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UNITED STATES NATIONAL MUSEUM.

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BY

LEONHARD STEJNEGER,
Curator of the Department of Reptiles and Batrachians.

From the Report of the U. S. National Museum for 1893, pages 337-487,
with plates 1-19, and figures 1-70.

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THE POISONOUS SNAKES OF NORTH AMERICA.

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It is the purpose of the present paper to give in a convenient form a review of our knowledge concerning the poisonous snakes of North America; to make the results of the specialists in the field accessible to a larger public; to bring together in one place a summary of an immense literature very often beyond the reach even of the student; to point out where our knowledge is defective, and to suggest new avenues of research.

Many popular errors will be corrected, while others will be disposed of by a simple statement of facts, from which the reader is expected to draw his own conclusions. No attempt will be made to discuss and controvert the purposely exaggerated stories with which the literature of the day abounds.

THE SO CALLED "HARMLESS" POISONOUS SNAKES.

If a snake is caught, killed, or seen, and any question raised as to its poisonous or harmless nature, it will be found that the presumption of guilt is against it, and that incontrovertible proof will be required by even highly educated people, not specially informed, before they are willing to believe in its innocence. An expert insisting that the snake in question belongs to a species wholly devoid of poison would probably during this discussion be met with the statement that a serious case of poisoning had once come under the observation of one of the persons present, the result of a bite of this very kind of snake. In spite of the fact that nothing is commoner and easier than misidentification of snakes, and that consequently the bite might have been caused by a really different kind of snake, the expert would not be in a position to contradict the accuracy of the statement, though he might be able to recall to his opponent quite a number of similarly serious cases resulting from the bites of animals unquestionably non-poisonous in the accepted meaning of the word. He might quote Livingston's statement that the bite of the large felines is commonly followed by symptoms of poisoning, and he would relate cases of swelling and inflammation of serious

extent, perhaps even death, undoubtedly caused by the bites of rats, dogs, cats, cows, horses, and even man himself.

It is clear then that we can not always conclude that a snake belongs to a venomous kind from the fact that its bite results in symptoms of poisoning. Modern science shows us that such results in other animals are due to the presence in their saliva of those minute organisms, the bacteria whose name at least is nowadays so well known to everybody. The general public knows these cases as blood-poisoning, the professional man refers to them as cases of septicæmia. The fact that the poison of snakes is only a modified saliva should not lead anybody to suppose that snake poison and the bacteria-infected saliva—though both may lead to fatal results—have anything in common in their nature. On the contrary, the sooner both the general public and the medical practitioner understand this difference and act accordingly, the better.

When speaking of poisonous or venomous snakes, therefore, I shall only refer to such snakes as are provided with a specific—to them peculiar—poison and an apparatus especially adapted for the introduction of this poison into the wound of the victim.

The question naturally will be asked: "Which, then, are our poisonous snakes?"

The proper answer would be that only those of our snakes are referable to this category which are possessed of a movable or constantly erect poison fang at the anterior end of the upper jaw bones, and even those who, on slight information, profess to be well informed, would in most cases admit that the above answer is correct. But it may be shown that this is only partly so.

Students of snakes have for more than fifty years kept an eye on a certain category of snakes as "suspects."

It seems that the Dutch professor, Reinwardt, while in Java, was the first to discover that certain snakes, dreaded by the inhabitants of that island as venomous, are provided with long grooved fangs at the posterior end of the maxillary bone. He communicated this discovery to Dr. H. Boie in Leyden, who published it in 1826.* The suspicion expressed by Prof. Reinwardt that this channel or groove on the anterior side of these fangs might convey the fluid from a poison gland led to several important investigations, the first of which to be published was Dr. Hermann Schlegel's memoir on the salivary glands of the serpents with grooved teeth.†

He came to the conclusion that inasmuch as he found the structure of their glands to be similar to that of other salivary glands, there could be no doubt that they secrete "a fluid similar to the ordinary saliva;" and as "recent observations of travelers" served to show that the bites of snakes with grooved teeth produce no fatal results to man, he

*Oken's Isis, 1826, p. 213.

†Nova Acta Acad. Leop. Nat. Curios., Bonn, XIV, 1828 (pp. 145–154).

asserted with characteristic positiveness that it is "erroneous" to class with venomous serpents those snakes which have the posterior teeth long and channeled. However, a short time after, Prof. G. L. Duvernoy, of Strasbourg, published a no less important treatise on the subject.* He pointed to the yellow portion of the supramaxillary gland as being structurally different from the white portion, and from its being connected with a large grooved fang by a single duct he concluded, with equal assurance, that we have here before us a venom apparatus only in degree differing from that of the snakes with poison fangs fixed to the anterior end of the maxillary bone. His results were accepted and introduced into the classification adopted in the monumental herpetological work of Duméril and Bibron, the Erpétologie Générale, in which the snakes with grooved posterior fangs were placed in a separate group as "*Opistoglyphs*." On the other hand, Schlegel, paying no attention whatever to Duvernoy, in his "Physiognomie des Serpentes," maintained his standpoint, and so great was the authority of the learned Leyden professor that his view was until quite recently accepted by some of the most prominent systematists. It seems that neither side ever attempted to end the dispute by direct experiments, and gradually the *Opistoglyphs* to many herpetologists ceased even to be "suspected."

About ten years ago the interest in this question was suddenly revived, and as it may now be fairly regarded as a burning one, some space will be devoted to a short review of several of the recent investigations into this theme.

Two Italian students, M. G. Peracca and C. Deregibus, were led to make special investigations into the possible venomous nature of *Malpolon lacertina* (=*Cœlopeltis insignitus*), a snake common about Nizza and in parts of Italy. In a communication to the Academy of Medicine at Turin, in May, 1883,† after first describing the grooved fangs, the glands, and the duct leading to the fang, they recounted their experiences with the snake in question:

Their experiments were carried out with two specimens of *Cœlopeltis* (=*Malpolon*), one of medium size, the other much larger; the victims consisted of lizards, frogs, and toads. The snake did not bite them voluntarily; it was necessary to open its mouth and to force the animal, into its throat; whereupon the snake inoculated the venom, the motion of the bone carrying the poison fangs being very distinctly seen on account of the manner in which they were standing out from the posterior part of the head. The act of biting lasted some moments, and the snake repeated this act several times without allowing its prey to escape.

The animals were bitten in the hind limb; in the case of the frog the skin had to be removed from the part to be bitten, as the irritating

* Ann. Sci. Nat., XXVI, 1832, pp. 144–156; XXX, 1833, pp. 6–26.

† Giornale della R. Accademia di Medicina di Torino, (3) XXXI, 1883, pp. 379–383.

secretion of the skin appeared to be particularly distasteful to the snake. Without reciting the various experiments in detail, the authors state the more apparent phenomena accompanying them to be, (1) the suspension of the respiration, which, in the main, occurs in a very few minutes (thirteen minutes being the maximum in a toad) and may happen suddenly, or may be preceded by a gradual sinking interrupted by a deep breathing pause; (2) the cessation of reflex movements in the bitten limb, while still persisting for some time in the rest of the body; the excitements applied below the bitten point ceased almost immediately to be transmitted to the medulla and to show reflexes. This alteration maintained itself local for some time, afterwards progressing toward the periphery along the nerves of the wounded limb. The general paralysis does not delay long in coming. It is but rarely accompanied by convulsions. The heart continues to beat for a long while (in the toad) but its strength decreases gradually. The blood revealed nothing notable under the spectroscope; as a matter of course it had become venous at the suspension of the respiration. The rapid changes which were observed at the wounded point are noteworthy; the muscular tissue became livid and inexcitable. Death ensued generally in half an hour, or less; in a toad it took place in twenty-six minutes. The heart of a frog continued to beat for many hours after. The authors then call attention to the interesting similarity between the above symptoms and those accompanying the poisoning by the cobra de capello, and finally state that they have made controlling experiments with innocuous snakes which did not have such effect upon the animals bitten.

In a subsequent résumé of this article* the same authors add that the effects of the bite of the *Malpolon* are not to be feared by man. "It seems," they say, "that the bite is only dangerous to reptiles, birds, and small mammals (mice); young dogs have resisted the poison rather well."

Similar investigations and experiments were carried out about the same time, or a little earlier (1882), on an American species in Guanajuato, Mexico, by Prof. A. Dugès, who has published his notes concerning *Trimorphodon biscutatus*,† a snake belonging to a genus representatives of which have been found along our Southern border. He gives figures of his dissections, showing the venomous gland with its duct supplying the grooved posterior fangs with the poison. He records his experience as follows:

> One day as I was admiring the snake I saw him seize a *Cnemidophorus sexlineatus* [the striped swift, a lizard], at the middle of the body, advancing its jaws so as to bring the corner of the mouth in contact with the body of the lizard; for several moments it *chewed* (a rare occurrence in a snake) its victim without the latter moving, letting go after having killed it; but at this juncture the saurian was swallowed

* Archives Italiennes de Biologie, v, 1884, pp. 108–109.

† La Naturaleza, (Mexico), VI, 1884, pp. 145–148.

by another snake (*Ophibolus doliatus*) which was kept in the same cage, thus preventing me from finishing the observation. A few days after, the same Trimorphodon caught another *Cnemidophorus* by the left arm and *chewed it several times.* At the end of a few minutes the bitten animal died without convulsions, without agitation, as if asleep, a little blood issuing from the wound.

A little later (1885), Mr. Otto Edmund Eiffe* published some observations, also made in 1882, on *Tarbophis vivax*, an opistoglyph snake inhabiting the countries bordering on the Eastern Mediterranean, and from his account we quote as follows:

I offered the half-grown snake a perfectly healthy *Lacerta vivipara*, which he at once commenced to lap with his tongue and then grasped slowly behind the fore legs. The lizard defended itself as best it could and used its teeth well on the enemy. In less than a minute the lizard was almost motionless, the jaws were powerless, and the eyes closed; before the expiration of another half minute the lizard died, and was then swallowed.

Prof. Léon Vaillant, of the Museum of Natural History, at Paris, observed the poisonous effect of the bite of another of the opistoglyph snakes, *Tragops prasinus*, Wagler, and gives the following interesting account of one of the observations:†

A small living green lizard was presented to the snake by means of a forceps. The snake seized it across the neck without descending from the shrubbery among which it used to live, and by the play of the jaws drew it back to the corner of the mouth. The lizard tossed and bent about, winding its body and tail round the head of the snake; three minutes later it hangs down inert, only the tail still trembling; after a similar space of time convulsions of the whole body occur again, twining itself around the head, then relapsing without motion, except some spasmodic undulations of the tail; this lasts for two minutes, and the animal is dead. It will be seen that this poison must have been tolerably active, as it caused the death of the lizard in about eight minutes after the puncture by the fangs, which must have taken place when the lizard reached the angle of the mouth, as the snake made no movement after that.

It seems quite plain from these observations that we have here to do with a specific poison. The victims succumbed within a very short time, and while it is evident that death was not caused by the mechanical injury inflicted by the bite, much less by the shock, there is as little room for assuming that it was due to the action of bacteria-infected ordinary saliva.

These experiments have again roused the interest in the morphology and physiology of these glands, and two years ago, sixty years after Duvernoy's work, Mr. F. Niemann published‡ some investigations upon this subject. Among other snakes he dissected and described two species with posterior grooved fangs, and he clearly demonstrates that, in both, the yellowish gland has already passed the innocuous stage and become a true poison gland, though structurally somewhat intermediate—as are, in fact, the fangs. He found in both species the yellowish gland well circumscribed and clearly differentiated from the

* Zool. Garten, 1885, p. 45.

† Mém. Centen. Soc. Philom., 1888, Sc. Nat., p. 44 *.

‡ Archiv f. Naturgeschichte, LVIII, i, 1892, pp. 262–286, pl. XIV.

true supralabial gland, although both glands are contained in the same envelope of connective tissue, and he was able to trace the single duct leading from the yellowish gland to the groove of the posterior elongated fang. One of the species was *Tragops prasinus*, Wagler (the same species with which Prof. Vaillant experimented), and an inhabitant of the East Indies, the other being *Leptodeira annulata*, (L.), from tropical America. Fig. 1 is a copy of Mr. Niemann's schematic representation of the arrangement in the former. Fig. 2 shows a section of the grooved fang near its base, copied from the same author.

Fig. 1.
DIAGRAMMATIC LATERAL VIEW OF THE HEAD OF TRAGOPS.
a Poison gland; *b* supralabial gland.
(After Niemann.)

That these snakes are not entirely harmless, even to man, is evident from the very recent experience of Mr. J. J. Quelch, of Georgetown, British Guiana,* who was bitten on the first finger by a large specimen of the common red-white-and-black-banded snake, *Erythrolamprus venustissimus*, driving its hinder grooved teeth three times down into the flesh. About half an hour after, the finger became much swollen at the place and distinctly very painful. It was not till about four hours afterward that real relief was obtained, though the place was tender for a much longer time. Another case was that of the clerk in the Museum, who was bitten on the finger by a young specimen of the common frog snake or Mattipi, *Xenodon severus*, whose hinder enlarged teeth were driven deeply into the flesh, with a result similar to that described in the case of the other snake.

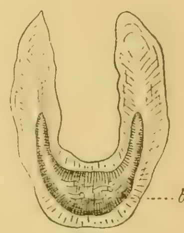

Fig. 2.
CROSS - SECTION OF GROOVED FANG OF TRAGOPS PRASINUS, NEAR BASE.
Enlarged. *a* Poison groove; *b* pulp cavity.
(After Niemann.)

It will be observed that while the snake by which Mr. Quelch himself was bitten is a true opistoglyph with grooved posterior fangs, the one which caused a similar result in the clerk, viz, the *Xenodon*, has the enlarged posterior teeth solid and not grooved. I would call attention to the fact, however, that this identical species is described by Duvernoy† as having the yellowish gland well differentiated. That the bite of the allied species, *Xenodon rhabdocephalus*, did apparently have no unpleasant effect on Dr. Stradling‡ is not difficult of explanation in view of the fact that occasionally the bite of even some of the most dangerous snakes has been ineffective, but enough is said to show that the question is not an unreasonable one: Is it essential for a truly venomous snake to possess *grooved* fangs?

As a matter of fact, at the very moment of this sentence going to press, the question seems answered conclusively in the negative by the experiments of Phisalix and Bertrand, who have shown that the saliva

* Zoologist (3), XVII, January, 1893, pp. 30–31.

† Ann. Sc. Nat., XXX, 1833, pp. 14–15.

‡ Referred to in Miss C. C. Hopley's, "Snakes, etc." 1882, p. 400.

of even ordinary solid-toothed harmless snakes contains the same specific poison which characterizes the dreaded thanatophidia. Fuller account of their discoveries will be found in the concluding chapter of this treatise.

However, since the character of the saliva of the harmless snakes does not seem to play any role in their economy, so far as obtaining food, or defending themselves against enemies, is concerned, we are still justified in regarding the opistoglyphs as a distinctly specialized group of poisonous snakes, aside from any consideration of their probably more or less close genetic relationship.

Although thus in the strictest sense poisonous, these comparatively harmless snakes do not claim the deep interest which snakes, dangerous to human life, through dread of the mysterious power excite in the popular mind. No attempt will be made then to treat of their structure and other peculiarities, in the present connection, beyond remarking that we have within the confines of the United States the representative of four genera of opistoglyph snakes, which may easily be referred to their respective divisions by the following characters:

Synopsis of the Opistoglyph Snakes occurring in the United States.

a^1 Head but slightly distinct; pupil round; no scale-pits.
- b^1. No loreal .... *Tantilla.* *
- b^2. Loreal present .... *Coniophanes.* †

a^2 Head wide, very distinct; pupil vertical; two scale-pits.
- b^1. One loreal .... *Leptodeira.* ‡
- b^2. Two or more loreals .... *Trimorphodon.* §

THE CORAL SNAKES.

FAMILY ELAPIDÆ.

There has been almost as much doubt about the poisonous nature of the Coral Snakes, *Elapidæ*, as of those mentioned in the preceding chapter, but as there has been enough evidence to show that the bite of these pretty animals may be fatal even to man, and as they are undeniably very nearly related to the deadly cobra, || the scourge of India, the verdict has decided against them long ago.

There are numerous doubters yet, however. Letters are often received from Florida asking whether the Coral Snake, or Harlequin Snake found

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* *Tantilla*, BAIRD and GIRARD, Cat. N. Am. Serp., p. 131 (1853) [=*Homalocranion*, DUMÉRIL, Prodr. Class. Ophid., p. 94 (1853)]. Type *Tantilla coronata*, B. & G.—Four species, ranging from South Carolina to southern California and south.

† *Coniophanes*, HALLOWELL, Proc. Acad. Phila., 1860 (p. 484). Type *C. fissidens*, GÜNTH. One species from extreme southern corner of Texas.

‡ *Leptodeira*, FITZINGER, Syst. Rept., p. 27 (1843). [*Sibon* of authors, but not of Fitzinger.] Type, *Dipsas annulata*, SCHLEG.—One species from extreme southern corner of Texas.

§ *Trimorphodon*, COPE, Proc. Acad. Phila., 1861, p. 297. Type, *T. lyrophanes*, COPE.—One species from southern Arizona.

|| See plate 19.

there, is poisonous or not, and the Museum is asked to decide bets made by persons taking opposite sides on this question.

The cause of this diversity of opinion is usually that the person defending the character of the Harlequin Snake, by quoting cases in which the bitten persons did not suffer any more injury than if they had been bitten by an ordinary gartersnake, has mistaken the identity of the snake and confounded the really poisonous Harlequin Snake, or *Elaps*, with one or the other of two or three entirely innocent snakes which resemble it greatly in color and which inhabit the same locality. It is a remarkable fact that this curious imitation or "mimicry" of the gaily colored *Elaps* by one or more harmless species takes place almost throughout the range of the former. So close is the resemblance in some instances that even alleged experts have been deceived.

On the other hand, it appears that some, at least, of the species of *Elaps* are of a temperament so gentle that they only use their weapon in very extreme cases. Prince Max von Wied seems to have been the first to have raised the question as to the venomous character of two Brazilian members of the genus (*Elaps corallinus* and *Elaps marcgravii*), for he states* that he used to carry them about his person and that they never even attempted to bite. The prince can not well be suspected of mistaking the species, for not only was he an expert herpetologist, but he described and figured them both most accurately and minutely. Our own well-known *Elaps fulvius* has a defender of no less high standing among the students of reptiles, Mr. Holbrook, the South Carolinian author of the monumental "North American Herpetology," printed in five sumptuous quarto volumes, who states† that the individuals he had seen had been of a very mild character, and could not be induced to bite under any provocation whatever. "Indeed," he remarks, "although possessed of poisonous fangs, they are universally regarded as innocent snakes, and are constantly handled with impunity, never to my knowledge having injured any one." ‡

The "instruments of destruction" (which he refers to in the same paragraph) are the hollow fangs, fastened, one on each side of the upper jaw, to the anterior end of the maxillary bone. It will be seen that this is an arrangement exactly the reverse of what obtains in the opistoglyph snakes of the previous chapter, hence the genus *Elaps* and its allies are known as *proteroglyphs*.§ The fang being at the front of the mouth makes it much more effective as a weapon—in the opistoglyphs it can even hardly be regarded as such—and in it will be shown that the little beauty is fully capable of using it when required.

The following case is a celebrated one, and in many respects highly

* Beitr. Naturg. Brasil, I, p. 402 (1825).

† N. Am. Herpet., III, 2 ed., pp. 49-52 (1842).

‡ LeConte's statement to the same effect (Southern Med. Surg. Journ., IX, 1853, p. 652) is scarcely more than a copy of Holbrook's.

§ From the Greek πρότερος (proteros), anterior; γλυφή (glyphe), a groove.

instructive. For full details the reader is referred to the report upon it pubished by Mr. Frederick W. True* after the occurrence. A brief account is, however, inserted here.

The victim was Mr. Zeno Shindler, an employee of the U. S. National Museum, and the offender a medium-sized *Elaps fulvius*, received from Mr. James Bell, of Gainesville, Fla.

On June 1, 1882, between 2 and 3 o'clock in the afternoon, preparatory to making the color sketch from the live snake which should serve for a guide in painting the plaster cast to be made from it, Mr. Shindler attempted to transfer the snake from the terrarium to a glass jar, holding it tightly by the neck. At the moment he let go, the snake's tail touched the bottom of the jar, and before he had time to remove his hand the snake fastened its fangs in his left index finger. The snake did not strike like the rattlesnake, but bit hard closing the lower jaw upon the finger, and held on so firmly that it had to be wrenched off, by which operation one of the fangs was broken off in the wound.

The first symptoms, which appeared immediately after the bite, according to Mr. True, consisted of violent pain at the wound. The symptoms continued without material change to 4:30 p. m. At that hour the first symptoms of drowsiness or unconsciousness made their appearance, and remained until the morning of the third day.

At 7:30 p. m. on the day of the bite Mr. Shindler felt so ill that he deemed it prudent to call upon his physician, Dr. L. M. Taylor, of Washington, whose treatment is given in full in Mr. True's report.

In three days after treatment the patient felt in good health again. About two months after the event, however, pain set in once more at the bitten finger, extending to the knuckles; and after a few days an ulcer made its appearance above the latter.

Mr. Shindler's troubles were not yet over, and as the periodical recurrence of the symptoms have been very marked. I shall bring it down to date (December, 1894†).

Mr. Shindler tells me that every summer, a few days before June 2, the day he was bitten, the wounded finger commences to pain, mostly at night. A sore is formed and soon breaks open, and as a result the nail invariably comes off. The attack lasts for about two weeks.

Two years ago, however, and ten years after the accident, the recurrence was prevented by a remedy commonly used in Brazil against snake bite, and brought to Mr. Shindler from that country by his friend, Dr. A. de Bausset. The remedy consists of the leaves and stem of a vine (*Micania guacho*) an infusion of which was taken internally immediately before the expected recurrence of the symptoms, with the result that, although the pains arrived on time, no eruption took place. His experience in 1893 and 1894 was similar.

*American Naturalist, XVII, January, 1883, pp. 26–31.

† Dr. Yarrow has already reported the case up to 1886 (Medical News, L, 1887, p. 624).

Mr. True, in the same article, also published letters from two Texan physicians reporting three cases of bites by Coral Snakes, two of which ended fatally, the first ones on record, I believe.*

Dr. Thomas Kearney, of San Antonio, relates one case, as follows:

The following case of a bite of a Coral Snake, followed by death, occurred near Corpus Christi, Texas, during the last year of the "late unpleasantness." An infant child of Mr. Alexander Stringer was playing in the yard, and being attracted by the bright colors of a coral snake, grasped it near the middle. The screams of the child brought its parents to its relief, but too late; the snake had done its work. The child lingered in great agony until the following morning and died, as above stated. The snake, as described to me, was about 18 inches long.

The other cases were reported by Dr. J. Herff, also of San Antonio, who wrote that one of the bitten men died in twenty-four hours, while the other one recovered after an almost fatal prostration of thirty-six hours' duration:

The fatal case I know of came under my observation a few minutes before death occurred under the symptoms of paralysis of tne heart. The second case was brought soon enough for me to try stimulants—whisky, hypodermic injections of ammonia, and fomentations of digitalis leaves over the region of the kidneys. The man, a strong young Scotchman, recovered in three days, and felt only a feeling of tingling in his extremities for some time after. * * * Both men kept the snakes as pets, and the last one used to put his finger in the animal's mouth very often to show how tame he was. One day he put it in a little deeper than usual, and while trying to extricate it the teeth bit him.

It would, however, seem that death from the bite of this snake is not so very uncommon, for Mr. Frederick A. Lucas informs me that a brother of Mr. S. A. Robinson, of Orlando, Fla., has told him that he knows of three fatal cases. I may also refer to the cases recently reported by Dr. Einar Lœnnberg in the Proceedings of the U. S. National Museum (vol. xviii, 1894, p. 334).

That great authority on snake poison, Dr. S. Weir Mitchell, of Philadelphia, nevertheless asserted † as late as 1889 that "the beautiful Coral Snake, the little *Elaps* of Florida," is "too small with us to be dangerous to man." Dr. Paul B. Barringer, of the University of Virginia, in a well-written account of "The Venomous Reptiles of the United States," read before the Southern Surgical and Gynecological Association, November 12, 1891, ‡ strongly protests against this and quotes a case, reported by Mr. Charles E. Coe, § of a workman at Oakland, Orange County, Fla., who died from the effects of a bite. About half an hour after being bitten pains came on in his hand and arm, followed by drowsiness and a dull pain in the head. A doctor was called, but the man died eighteen hours after receiving the bite.

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* Harlan, however, states that the Harlequin Snake "may be fatally mistaken for the scarlet snake." (Med. and Phys. Researches, 1835, p. 127.)

† Century Magazine, XXXVIII, August, 1889, p. 505.

‡ Venomous Reptiles of the United States, p. 3.

§ Scientific American, LXIV, June 27, 1891, p. 401.

In view of these facts before us it will no longer answer to apply such adjectives as "harmless"* or "innocuous to man" † to a snake of which it is positively known that its bite is dangerous. It is granted that *Elaps* is comparatively rare; that it is retiring in its habits, mostly living under ground, and that it has a very gentle and amiable temperament. When it does bite, however, its bite is as venomous as that of a rattlesnake or moccasin of the same size, and even more so. It is probably quite true that the snake, in all the cases referred to above, was handled roughly and provoked beyond endurance; but it is also true that it would not, in most cases, have had an opportunity to do the mischief, if it had not enjoyed such an excellent reputation.

It has been repeatedly asserted that the mouth of the *Elaps* is so small that it can not bite as well as the other poisonous snakes. This, however, is somewhat of a mistake. Externally and superficially the head of the *Elaps* appears very short and narrow, and the opening of the gape of but slight capacity. An examination of the skeleton, however, shows the skull to be comparatively large and rather elongate, especially the cranial part, which occupies fully two-thirds of the total length of the head. The articulation of the lower jaw, which is correspondingly lengthened, is consequently far enough back to permit, by means of the elasticity of the ligaments, the opening of the mouth quite out of proportion to the external aspect of the snake.

That this capacity is not a theoretical one is shown by the fact that an *Elaps fulvius* has been found which contained a well-preserved whip snake, of the same length as the *Elaps*, besides the half-digested remains of a garter snake. The body of the *Elaps* was so distended that the scales, instead of overlapping, were separated from each other by considerable spaces of skin. ‡

The good reputation of the *Elaps* in combination, on the one hand, with the apparent insignificance of the wound and the lack of alarming local symptoms, on the other with the great similarity it bears to really harmless snakes, makes its bite more fatal in proportion to the number of reported cases than any other snake in the country. The wounded person usually does not know his danger, and does not take the proper measures against a puncture which on the surface looks so innocent; and as the action of the specific venom of the *Elaps* is both quick and violent when admitted into the circulation of the blood, the remedies when finally applied can do but little good.

Morphologically the *Elaps* is not distantly related to the cobra of India, § that is, they agree closer in external and internal structure than either of them does with the typical harmless snakes on the one hand, or with the vipers on the other.

* Jordan, Manual Vertebr. Anim., 5th ed., 1888, p. 198.

† Cope, Proc. U. S. Nat. Mus., XIV, p. 680 (1892).

‡ Matthes, Denkschr. Naturw. Ges. Isis, 1860, p. 58.

§ For an illustration of this, the most terrible of all the death-serpents, see pl. 18.

That their venom also is more nearly the same than is that of the cobras and the rattlesnakes there can be no doubt. As will be shown later on, the poison of these last-mentioned snakes has been investigated and found to be considerably different, and although no examination of the chemical composition of the *Elaps* poison has been made as yet, as far as I know, the similarity in the symptoms shows that the venom of the cobra and the Coral Snake are very much alike.

In Mr. Shindler's case the doctor's report does not mention any local symptoms beyond the swelling of the finger, and Mr. Shindler informs me that there was no discoloration, as in the case of rattlesnake bites, beyond the reddening near the wound. The absence of special mention of violent local changes in the other cases is indication enough that none took place, while Dr. Herff expressly states that "different from our common poisonous snakes, the bitten part would neither swell nor become discolored," nor could anything be observed on the wound, except the small impression caused by the teeth of the serpent. But this absence of local effect is just one of the essential characteristics of the cobra poison as contrasted with that of the rattlesnake.

I have alluded to the extraordinary similarity between the *Elaps* and several perfectly harmless snakes inhabiting the same region, and it is quite probable that the innocent nature of the latter is in a great measure responsible for the former's good reputation, just as reversely several of the harmless snakes have received bad names on account of their external similarity to the venomous moccasin or copperhead.

It will therefore not be amiss to institute a comparison between the coral snakes and their imitators,* in order to furnish a means of readily distinguishing the venomous and dangerous reptiles from the innocuous ones.

With the dead specimens in hand the correct identification is not difficult. In the first place, the *Elaps* is provided with permanently erect, perforated fangs, that is, there is found at the front end of each upper jawbone one solitary curved tooth, which has a channel running through its center and a groove on its anterior surface, and which is not followed by any other teeth † on the upper jawbone, while the other snakes with which it can be confounded have no such perforated fang but instead a series of smaller solid teeth on the entire length of the bone in question (figs. 3 and 4). Running the point of a pin or a penknife along the bone just inside the upper lip will soon disclose the presence or absence of these teeth. There are several other minor points of structure and proportion which serve to distinguish the *Elaps*.

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*It seems as if the harmless snakes are the imitators, and not *vice versa,* because the peculiar coloration of the various species of *Elaps* is more or less the same everywhere, while the harmless snakes resembling them belong to many different genera, in some of which there occur species of widely different color and pattern.

† Except, of course, the reserve fangs, likewise grooved.

Thus it has very small eyes, smaller than the shields between which the nostrils are placed, while in the inocuous snakes the eyes are considerably larger. The snout of the *Elaps* is short, blunt, and rounded, while in the others it is elongate, conical, more or less pointed. Moreover, in the former the frontal shield is small, less than one-half the size of one of the parietals, the latter much more than one-half.

Fig. 3.
PROFILE VIEW OF SKULL OF ELAPS.
(After Jan.)

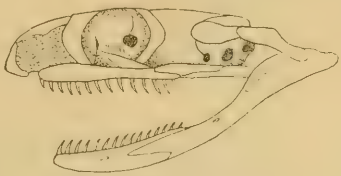

Fig. 4.
PROFILE OF SKULL OF LAMPROPELTIS
(After Jan.)

With the live animals, free or captive, these characteristics are often difficult of application. In such cases it is necessary to rely upon differences in the color pattern as a means of identification.

There are in the United States only two well-defined species of *Elaps*. The characteristic coloration of these consists of a series of transverse rings of black, vermilion, and yellow. This pattern is repeated in several species and subspecies of the genus *Lampropeltis* (or *Ophibolus*), known as "Scarlet King-snake," *L. doliatus;* "Red king snake," *L. coccineus;* "Ringed King-snake," *L. annulatus;* "Arizona king snake," *L. pyrrhomelas*, etc., as well as "Osceola's Snake," *Osceola elapsoidea;* the "Scarlet Snake," *Cemophora coccine*, and to a less extent in "Le Conte's Snake," *Rhinocheilus lecontei*, all or some of which inhabit the same region as one or the other species of *Elaps*. In all of these red, black, and yellowish is arranged in more or less perfect transverse rings. Le Conte's Snake is less characteristic and like the *Cemophora*, easily told apart by having the entire under surface whitish, while in the others, including the *Elaps*, the red and black is more or less continued across the belly. There is one fundamental difference in the arrangement seen in the species of *Elaps* within our boundary and that in *Lampropeltis*, *Osceola*, and *Cemophora*, which is that in our *Elapes* that black rings are borderd on each side by a yellowish ring (fig. 5) while in the others the yellow rings are bordered on each side by a black ring (fig. 6).

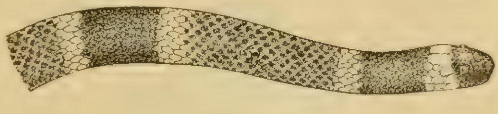

Fig. 5.
COLOR PATTERN OF ELAPS.
(After Jan.)

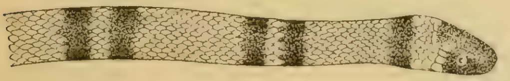

Fig. 6.
COLOR PATTERN OF LAMPROPELTIS.
(After Jan.)

The difference is well shown in the accompanying figures, which also bring out several of the structural characters referred to above.*

A formal though condensed account of the natural history of the *Elapidæ* occurring within the United States is here presented.

Genus ELAPS,† Schneider.

The Coral Snakes.

1801.—*Elaps*, Schneider, Hist. Amphib., II (p. 289).—Günther, Proc. Zool. Soc., Lond., 1859, p. 84.

Postfrontal bone wanting; internasal plate not reaching labials; two nasals; no loreal; subcaudal shields (urosteges) divided; eyes very small, pupil a short vertical ellipsoid.

The snakes of this genus are cylindrical, rather elongate, but with short tail, and characterized by bright colors of red, black, and often yellow, forming rings. In many of the exotic species the black rings are arranged in threes, while in the North American species those of the body are equidistant. The scales are smooth and iridescent.

The exact number of species can not be given at present on account of the uncertainty of the status of many of the described forms, but at least twenty inhabit the New World, of which only two occur north of Mexico.

While the poison apparatus of the rattlesnakes and their nearest relations has been studied very minutely, that of the genus *Elaps* has been sadly neglected, as has been, in fact, its entire anatomy. Drs. Matthes and Voigtlænder have given short and superficial accounts of *Elaps fulvius*, from which ‡ I make a few abstracts: The functional fang in *Elaps fulvius* is followed by reserve fangs of the same structure as the functional one, but successively smaller. The functional fang is solidly united to the maxillary bone, being directed backward at a permanent angle of about 45° with the latter. Although comparatively smaller than the fangs in the crotalid snakes, that of *Elaps* is large enough to distinguish it at the first glance as different from the solid teeth of the palate and of the lower jaws. In front, at the base of the fang, the opening of the canal is distincly visible, and on the convex, or anterior, surface of the fang a shallow groove. The terminal slit, being the lower opening of the canal, is situated slightly on the *outer* side of the fang.

As already stated there are found in the United States only two well defined species of *Elaps*, but these are so sharply defined that they may be told apart at a glance, by the following characters:

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* The brilliant colors of all these snakes fade soon in alcohol; the red becomes grayish or light brownish; the yellow grows pale, often quite white; and the deep black, often bluish, turns a dull brown.

† From ἔλαψ (elaps), a Greek name for a snake.

‡ Denkschr. Naturw. Gesell. Isis, 1860, pp. 52–59, and p. 64.

HARLEQUIN SNAKE,—ELAPS FULVIUS.
From Baird, Rep. Mex. Bound. Surv.

Synopsis of species of Elaps occurring in the United States.

Snout and frontal black, parietals yellow, followed by a broad black ring. *Elaps fulvius.*

a^2 Snout, frontal, and parietals black, followed by a yellow ring and this by a broad red one .... *Elaps euryxanthus.*

There are, besides, several important characters derived from structural and proportional differences, notably in the size of the frontal and the internasal shields.

As a rule *E. fulvius* differs from *E. euryxanthus* in having the second row of temporals consisting of only one shield against two in latter; but this character is by no means constant.

The Harlequin Snake.

Elaps fulvius,* (Linnæus).

Plate 1.

1766.—*Coluber fulvius*, Linnæus, Syst. Nat., 12 ed., I, p. 381.—Daudin, Hist. Nat. Rept., VII, p. 300 (1803).—Say, Sillim. Am. Journ. Sc., I, 1819, p. 262.—*Elaps fulvius* Fitzinger, Neue Class. Rept., p. 61 (1826).—Holbrook, N. Am. Herpet., 1 ed., II, p. 87 (1838);— 2 ed., III, p. 49 (1842).—DeKay, Zool. N. Y., III, p. 58 (1842).—Girard, in Baird and Girard, Cat. N. Am. Serpents, p. 21 (1853).—Le Conte, South. Med. Surg. Journ., IX, 1853, pp. 651, 652.—Duméril and Bibron, Erpét. Gén., VII, ii, p. 1215 (1854).—Günther, Cat. Colub. Snakes Br. Mus., p. 235 (1858).—Cope, Proc. Phila. Acad., 1859, p. 344 (1860).—Cope, Bull. U. S. Nat. Mus., No. 17, p. 24 (1880).—Cope, Proc. U. S. Nat. Mus., XII, 1888, p. 398 (1889).—Jan, Prodr. Icon. Ophid., p. 6 (1859).—Jan, Elenco Sist. Ofid., p. 113 (1863).—Matthes, Denkschr. Naturw. Ges. Isis, 1860, p. 52.—Voigtländer, Denkschr. Naturw. Ges. Isis, 1860 p. 64.—Smith, Rep. Geol. Surv. Ohio, IV, p. 676 (1882).—Garman, N. Am. Ophid., pp. 105, 168 (1883).—Garman, Bull. Essex Inst., XXIV, p. 5 (1892).—True, Amer. Naturalist, XVII, 1883, p. 27.—True, in Hammond's South Carolina, p. 235 (1883).—Yarrow, in Buck's Ref. Handb. Med. Sc., VI, p. 166 (1888).—Jordan, Man. Vert. North. U. S., 5 ed., p. 198 (1888).—Ferreira, Jorn. Acad. Sc. Lisbon (2) II, Sept. 1891 (p. 91).—Barringer, Ven. Rept. U. S., p. 2 (1891).—Butler, Journ. Cincinnati Soc. Nat. Hist., 1892, p. 178.—Hay, Batr. and Rept. Indiana, p. 121 (1893).—*Vipera fulvia*, Harlan, Journ. Phila. Acad., V, ii, 1827, p. 364.—Harlan, Med. Phys. Researches, p. 127 (1835).

1802.—*Coluber fulvus*, Shaw, Gen. Zool., III, i, p. 469.—Latreille, Hist. Nat. Rept., IV, p. 140 (1802).—*Elaps fulvus*, Hoy, Smiths. Rep., 1864, p. 433.—Günther, Proc. Zool. Soc. Lond., 1859, p. 85.—Bigney, Proc. Md. Ac. Sc., 1891, p. 151 (1892).

1825.—*Coluber fulvius*, var. (H), Harlan, Journ. Phila. Acad., V, i, p. 155.—Harlan, Med. Phys. Res., p. 180 (1835).

1853.—*Elaps tenere*, Girard, in Baird and Girard, Cat. N. Am. Serpents, pp. 22, 156.—Matthes, Denkschr. Naturw. Ges. Isis, 1860, p. 52.—Garman, Bull. Essex. Inst., XXIV, p. 5 (1892).

1853.—*Elaps tristis*, Girard, in Baird and Girard, Cat. N. Am. Serpents, p. 23.—Matthes, Denkschr. Naturw. Ges. Isis, 1860, p. 52.—Yarrow, Bull. U. S. Nat. Mus., No. 24, p. 82 (1883).

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* From the Latin *fulvius*, for *fulvus*, tawny; misnamed from the the color of an alcoholic specimen.

1859.—*Elaps tener*, BAIRD, U. S. Mex. Bound. Surv., II, Rept., p. 15.—GÜNTHER, Proc. Zool. Soc. Lond., 1859, p. 86.

1875.—*Elaps fulvius*, subspecies *fulvius*, COPE, Bull. U. S. Nat. Mus., No. 1, p. 34.

1875.—*Elaps fulvius*, subspecies *tener*, COPE, Bull. U. S. Nat. Mus., No. 1, p. 34.

1883.—*Elaps fulvius fulvius*, YARROW, Bull. U. S. Nat. Mus., No. 24, p. 81.

1883.—*Elaps fulvius tener*, YARROW, Bull. U. S. Nat. Mus., No. 24, p. 81.

1883.—*Elaps fulvius*, var. *tener*, GARMAN, N. Am. Ophid., p. 169.

Figures. AUDUBON, Birds, I (pl. XLIV).—HOLBROOK, N. Am. Herpet., 1 ed., II, pl. XVIII (1838); 2 ed., III, pl. X (1842).—BAIRD, U. S. Mex. Bound. Surv., II, Rept., pl. VII; fig. 1 (1859).—BAIRD, Pac. R. R. Rept., X, pl. XXV, fig. 15 (1859).—MATTHES, Denksch. Ges. Isis., 1860, pl. —, figs. 1-5.—JAN, Iconogr Ophid., livr. 42, pl. II, fig. 2 (1872).—BOCOURT, Miss. Scientif. Mexique, Rept., livr. 4, pl. XXIII (1874).—GARMAN, N. Am. Ophid., pl. VIII, fig. 3 (1883).—YARROW, in Buck's Ref. Handb. Med. Sc., VI, p. 167, fig.—(1888).

*Description.**—The red may be considered as the ground color of the body, though the black rings occupy nearly as much space above as the red, so as to give the general appearance of succession of red and black rings. The yellow is intermediate. The anterior part of the head from the posterior point of the vertical plate [frontal] embracing the orbits is black, as is also the tip of the lower jaw. A yellow ring passes across the occipital [parietal] region down to the inferior surface of the head, embracing the space between the posterior rim of the eye and the angle of the mouth. Then comes a black ring, covering 8 dorsal scales, margined posteriorly with yellow. From this region to the origin of the tail, the black and red rings from 14 to 19 in number each, alternate, being separated from each other by a narrow band of yellow. The black rings cover 7 entire scales, and 2 halves; the intermediate red space 5 entire scales and 2 halves, and the yellow either 1 and 2 half scales or 2 halves only. Some red spaces may occasionally cover 9 and 10 scales. The tail is alternately black and yellow; the first caudal ring is black and embraces 10 scales; the second is yellow and covers 3 scales. Two black and 2 yellow succeed and cover the same ground. The tip of the tail is black on 5 scales. The tip may be either black or yellow, for according to the size there are either 3 or 4 black rings. Underneath the colors are the same but dull; occasionally one or more black rings may not surround the body. The reddish spaces are irregularly blotched with deep black as also sometimes on the upper surface.

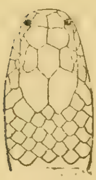


Fig. 7.

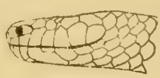


Fig. 8.

HEAD OF ELAPS FULVIUS.
Shown from top and side.
(From Baird.)

Number of ventrals [gastrosteges], 202–237; of sub-caudals [urosteges], 25–45.

Variation.—The typical form of *Elaps fulvius* occupies the southeastern States, including Florida. Further west there is a slight

*By C. Girard in Baird and Girard's Catalogue of North American Reptiles in the Museum of the Smithsonian Institution, Part I.—Serpents, 1853, p. 21.

tendency toward increasing the number of ventral shields (*gastrosteges*), narrower frontal and parietals, widening of the yellow rings, and greater size of black spots in the red rings. Individuals showing these characters well developed have been called *Elaps tenere*, or *Elaps fulvius tenere*, but there does not occur in any locality a sufficient percentage of individuals typical of the form to make it profitable to recognize a subspecies.

The status of some Florida specimens differing considerably in pattern from normally colored *E. fulvius* has not been satisfactorily settled as yet. They are stated not to differ at all in structure or proportions. Only a few specimens seems to have been collected—I have myself only seen one—and that in a locality in which the normal form also occurs. More material is highly desirable. Prof Cope calls them *Elaps distans*. The chief difference from typical *E. fulvius* consists in the greater width of the red rings, which are not spotted with black, and the consequent narrowing of the black rings to 2 or 3 scales.

Geographical distribution.—I do not know how reliable the information was, upon which Holbrook states that the range of this species may "be said to begin in North Carolina and southern Virginia," for I am not aware of any definite record of specimens taken in those States, though it may well occur there, as we have quite a number of records and specimens from South Carolina even as far north and back in the country as Society Hill and Columbia. It extends over Georgia and the entire State of Florida. From Alabama, Mississippi, and Louisiana there are numerous records. The Bead Snake evidently follows the Mississippi River up a considerable distance notwithstanding the meagerness of details known, and notwithstanding the fact that the vigilant observers in St. Louis, among them Mr. Julius Hurter, have failed to find it. It even ascends the Missouri River, as Dr. Hoy obtained it near that river in about 39° latitude. How much reliance can be placed upon the identity of the specimen which Holbrook quotes as in the possession of Prof. Green, of Philadelphia, and said to have been brought by Lewis and Clarke from the "Upper Missouri," I do not know, but almost certainly there is some mistake. Recently two specimens have been captured in southeastern Indiana and southwestern Ohio under circumstances which make it appear probable that the species occurs along the Ohio River (Hay, Batr. Rept. Indiana, p. 122; Butler, Journ. Cincinn. Soc. Nat. Hist., 1892, p. 178). In the southern part of Texas this snake is found in all suitable localities, ascending a considerable distance into the interior along the great river valleys. Thus along the Rio Grande it extends up to the mouth of the Pecos, even ascending the latter, as Capt. John Pope's specimens were collected certainly not farther south than the thirty-first parallel. In southern Texas, moreover, it reaches a higher altitude than farther east, viz, over 1,000 feet, while none of the records of the eastern localities show it to reach even an altitude of 500 feet.

Habits.—Comparatively little is known of the habits of this beautiful snake, which like its harmless mimickers is often known as the bead snake, beyond the paragraph by Holbrook (op. cit. p. 50) repeated by most writers on the subject since his days, viz, that it is found living under ground in the sweet potato fields, and is frequently dug up by the laborers when harvesting.

The food of the Harlequin Snake seems to consist chiefly of other snakes and reptiles. I have already referred to a specimen which had swallowed a *Bascanion* as long as itself before it had fully digested a garter snake. Dr. Matthes (op. cit., p. 58) opened three more *Elapes* with the following result: No. 1 contained a half-grown *Eumeces fasciatus;* No. 2 had in its stomach a small snake, remnants of a lizard and a few beetles, the latter possibly the contents of the lizard's stomach; No. 3 also contained a small snake besides remains of a small rodent. Dr. O. P. Hay (Batr. and Rept. Indiana, 1893, p. 122) reports having found a Storer's snake, 13½ inches long, in a Florida *Elaps*, 21 inches long.

Nothing at all seems to be known of the breeding habits of our harlequin snakes.

This group offers a promising field for study by persons having the opportunity to observe these snakes alive.

The Sonoran Coral Snake.

Elaps euryxanthus,* Kennicott.

Plate 2.†

1860.—*Elaps euryxanthus,* Kennicott, Proc. Phila. Acad., 1860, p. 337.—Cope, Proc. Phila. Acad., 1861, p. 296.—Cope, Proc. Phila. Acad., 1866 (p. 307).—Cope, Bull. U. S. Nat. Mus. No. 1, p. 34 (1875).—Cope, Bull. U. S. Nat. Mus. No. 32, p. 86 (1887).—Cope, Proc. U. S. Nat. Mus., xiv, 1892, p. 681 (1893).—Coues, Wheeler's Surv. W. 100 Mer., v, p. 611 (1875).—Streets, Bull. U. S. Nat. Mus. No. 7, p. 40 (1877).—Yarrow, Bull. U. S. Nat. Mus. No. 24, p. 82 (1883).—Garman, Rept. Batr., N. Am., Ophid., pp. 107, 169 (1883).—Cragin, Bull. Washburn Laborat., i, 1884, p. 8.

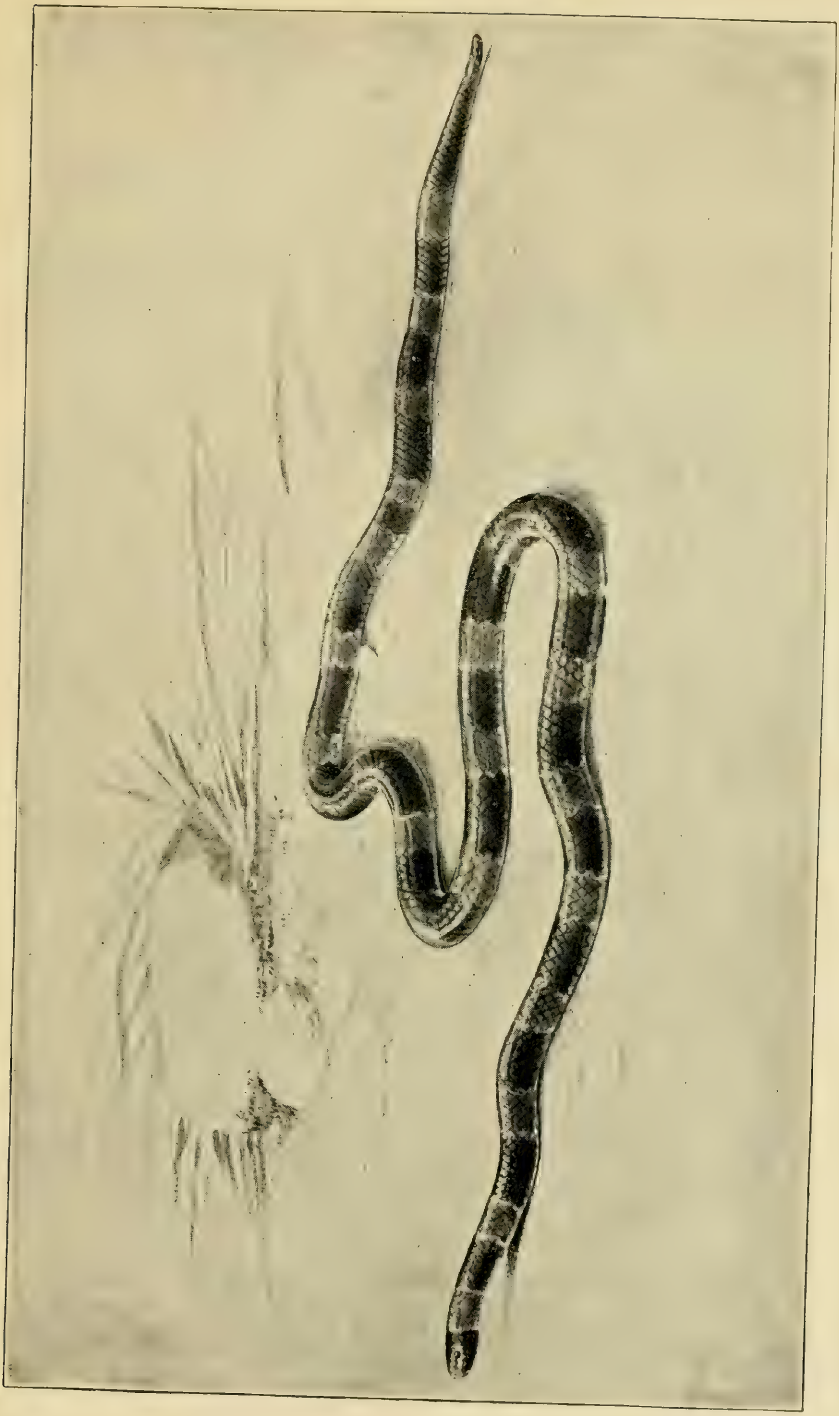
Figures. None.

Description.‡—Body rather stout, but less so than *E. fulvius.* Dorsal scales large; plates of the head small, except the rostral, which is very large and extends upward between the prefrontals [internasals]. Prefrontals [internasals] elongated laterally, more so than in *E. tener.* Postfrontals [prefrontals] small, elongated laterally; vertical [frontal] very small and narrow, subhexagonal, pointed anteriorly, elongated and tapering posteriorly; it enters but slightly between the occipitals. Occipitals [parietals] small, subtriangular, the anterior edge square,

* From the Greek εὐρύς (eurus) broad; ξανθός (xanthus), yellow.

† The figure cited is a half-tone reproduction of a colored drawing, hence the yellow interspaces are entirely too dark; it should be carefully compared with the description.

‡ Original description by Kennicott, Proc. Phila. Acad., 1860, p. 337.



SONORAN CORAL SNAKE,—ELAPS EURYXANTHUS
From a specimen in the U. S. National Museum.

very slightly notched for the vertical [frontal]. Seven labials above; posterior very small.

The fore part of the head is black, but the black, instead of passing forward from the anterior part of the occipitals [parietals] to near the eye, and there leaving the three posterior labials yellow as in *E. fulvius* and *E. tener*, involves nearly the whole of the occipitals [parietals], and passes backward entirely behind the angle of the mouth and involves the whole of the lower jaw to behind the posterior labial, leaving a broad emargination in the black on the occiput, in the bottom of which emargination are seen the white posterior tips of the occipitals [parietals].

Behind this is a creamy-white ring (probably yellow in life), which is situated more posteriorly than in *E. fulvius*, and involves only the posterior tip of the occipitals [parietals] and none of the labials. Next behind this white ring, instead of a black ring, as in the other species, is a broad light brick-red one involving eleven scales. A creamy-white ring three and a half scales wide separates this first red ring from a black one eight scales in width. Behind this are alternate immaculate black and red rings, seven or eight scales wide, and separated by white rings three to three and a half scales in width. There are eleven black and eleven red rings on the body, separated by twice as many white ones. The tail is ringed with black and white without any red. All the rings run entirely around the body of the same color and are wholly without spots above or below.

Number of ventrals (gastrosteges), 215–241; of subcaudals (urosteges), 21–29.

Geographical distribution.—This species is yet so little known that its distribution can only be mapped out in a preliminary manner. It belongs to the "Lower Sonoran" province, but seems restricted to the regions east of the great Colorado River and west of the Continental Divide. It has been found as far north as Fort Whipple and at various places in southern Arizona, extending south into Mexico at least as far south as Batopilas, in the State of Chihuahua, in the interior, and to Guaymas, Sonora, on the Gulf of California.

In Arizona it reaches an altitude above the sea of at least 5,000 feet.

Habits.—Absolutely unknown.

THE PIT VIPERS.

Family CROTALIDÆ.

"Pit Viper" is a "book name" meant to include the Rattlesnakes, Moccasins, Copperheads, etc., but unlike many others it is a most excellent one, for not only does it indicate the relationship of these snakes to the true vipers, but it also contains a reference to the remarkable character which at once distinguishes them both from the vipers and from all other snakes as well.

The name refers to the deep pit or hole found in the Rattlesnakes and their nearest relations on the side of the face between the nostril and the eye, and well shown in fig 9. This cavity sinks deep into the maxillary bone and represents a "blind" sac lined with epidermis and is not connected with any of the other cavities or organs in the head by any inside opening or canal. There is nothing similar to be found in any known reptiles outside of this family, if we except the labial pits in the pythons and boas, nor is there in any other class of animals. When the earlier zoologists came to examine this peculiar structure they, of course, tried to compare and identify it with other organs already known, some hinting at the closed nostrils of the fishes, while others pointed out its similarity, in position at least, to the so-called "tear-sacs" of the deer. It was even suggested that in view of the close approximation of the pit to the poison apparatus it might have for object the admission of air to act in some unknown way upon the secretion of the venom glands, thus rendering the poison more powerful.

Fig. 9.

HEAD OF CROTALUS, FROM SIDE.

i Infralabials; *l* loreal; l^1 lower loreal; l^2 upper loreal; *n* nasal; n^1 anterior nasal; n^2 posterior nasal; *p* preocular; *r* rostral; *s* supralabials; s^1 1st supralabial; s^2 2d supralabial, etc.; *so* supraocular

It was plain, however, even to those who proposed these explanations, that they were not the true solution of the question, and most authors were satisfied with a reference to the pits as "mysterious."

In the meantime naturalists have become compelled to assume the existence of a "sixth sense" in various animals, for which they had discovered special sense organs, such as, the lateral line in fishes.

It was quite natural, then, that Prof. Leydig should come to the conclusion that the pit of the *Crotalidæ* is the organ of a sixth sense, when upon a microscopic examination of the pit's lining he found it supplied with a thick nerve, ending in a way the only analogue of which is found in the retina of the eye or the labyrinth of the ear.

Leydig's material was in some respects defective, for he had only specimens preserved in alcohol, and in his valuable memoir* on the subject twenty-five years ago he distinctly encouraged the North American naturalists to take the matter up and continue his investigations on fresh specimens, but, as far as I know, nobody has as yet done so. It may therefore not be out of place to give a brief synopsis of his observations.

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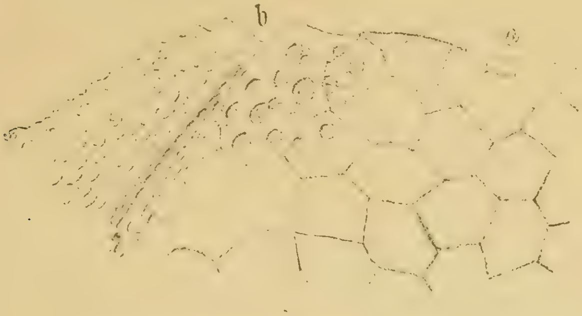
*Nova Acta Acad. Caes. Leopold. Nat. Curios., XXXIV, 1868, No. 5, pp. 89–96, pl. iv, figs. 28–32.

The external layer of the lining of the pit Leydig found to be a continuation of the outer skin, which, however, upon entering the cavity becomes thin and considerably modified. The granular tubercles gradually disappear toward the bottom, and the surface is found to be composed of large angular epidermis plates containing nuclei (fig. 10). Underneath this he found a layer of connective tissue, in which the fine ramifications of the thick nerve supplying the pit are lost in a granular substance which under high power reveals itself as containing numerous true, rounded, but pale nuclei. The granular substance he found arranged around the nuclei in such a way as to form groups or islands of various forms and sizes separated by light narrow spaces. These structures can only be regarded as terminal ganglions, and it does not seem doubtful that we have here to do with a true sense organ.



PIECE OF SURFACE OF EPIDERMIS LINING THE PIT.

Greatly enlarged. *a* Smooth, thin portion from the pit proper; *b* tubercular portion at the edge. (After Leydig.)

Wherein this "sixth sense" consists we do not know, nor do we know of anything in the habits of these snakes which would indicate its nature, or to what use the animal puts the organ. Future research may reveal it, though perhaps man will never fully comprehend the nature of a sense which he himself does not possess.

The "loreal" pit, so called because of its location in that portion of the snake's face in herpetological terminology known as the "lores," being a character exclusively pertaining to the Crotalid snakes, its presence in any of our North American snakes at once designates it as a dangerously poisonous snake. It is an unfailing character of our native "death vipers," with the exception of the *Elaps*, which I have already characterized.

Another unfailing character is, of course, the presence of long curved fangs in the anterior portion in the upper jaw. Since an account of our poisonous snakes would manifestly be incomplete were I to omit a description of the poison apparatus, a brief outline of its structure is here presented.

I stated above that *Elaps* has two permanently erect and perforated fangs in the anterior portion of the upper jaw. In the Pit Vipers

there are similar fangs, but much larger, and differing from those of the *Elaps* by being folded up toward the palate, somewhat like the blades of a jackknife when not in use. This must not be understood to mean that the fangs themselves are movable; on the contrary, the

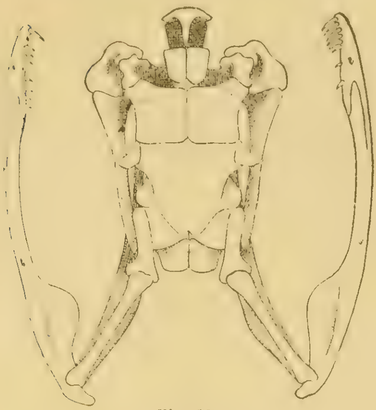


Fig. 11.
SKULL OF RATTLESNAKE, FROM ABOVE.
(After Jan.)

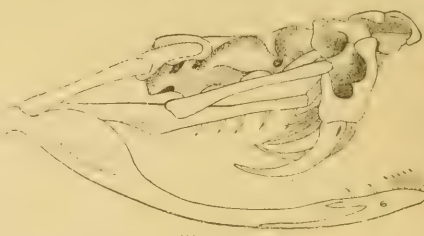


Fig. 12.
SKULL OF RATTLESNAKE, FROM SIDE.
(After Jan.)

viper's fangs are as solidly fixed in their sockets as are those of the *Elaps*, but while in the latter (see fig. 3) the maxillary bones, into which the fangs are fastened, are elongated and horizontal, as in the harmless snakes (see fig. 4), in the Crotalids they are extremely shortened and higher than long, so as to appear in a vertical position. In the former the fangs are consequently inserted nearly at right angles, like the pickax on its handle, while in the latter the fang more nearly represents the blade, and the jawbone the handle of a knife, and it is the jawbone which is movable in the vertical plane, not the fang alone.

Fig. 13.
SKULL OF RATTLESNAKE, FROM BELOW.
(After Jan.)

In order fully to understand the mechanism in question, it is necessary to remember that the bones of the head of nearly all snakes (figs. 11–13) are so loosely joined together as to allow a most extraordinary amount of movement and distention. Elastic ligaments connect bones which in other animals are either grown solidly together or articulated by means of close joints, hence a snake is capable of swallowing a prey many times as thick as the snake's own body.

As already noted, the upper jawbones (maxillaries) are situated vertically, one on each side of the anterior portion of the mouth, the hollow fang being fastened into the lower end of the bone. On the outer face

of the bone there is above a deep cavity forming the bony walls of the "pit" already referred to, which separates two articular surfaces. The upper one at the top of the maxillary forms with the corresponding concave face of the lachrymal bone, which projects from and articulates with the frontal bone, a hinge-like joint, allowing considerable freedom of motion. The lower surface receives the flattened anterior end of the external pterygoid bone. It will be seen from the accompanying cut (fig. 14) that if the latter bone (*a*) be moved forward or backward, the maxillary hinges on the lachrymal, and that if the pterygoid be pushed forward, the fang is erected.

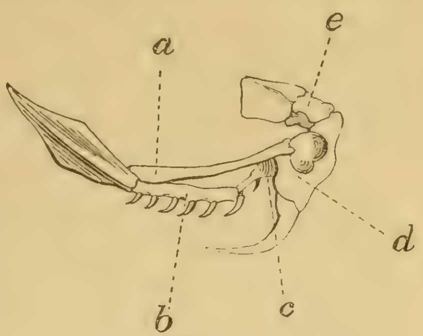


Fig. 14.
POISON APPARATUS OF THE RATTLESNAKE.
Right side. *a* External pterygoid bone; *b* internal pterygoid bone; *c* palatal bone; *d* maxillary bone; *e* lachrymal bone.
(After Mitchell.)

There are several muscles engaged in producing this erection and the opposite motion, the depression of the fang, but we shall only mention the two principal ones.

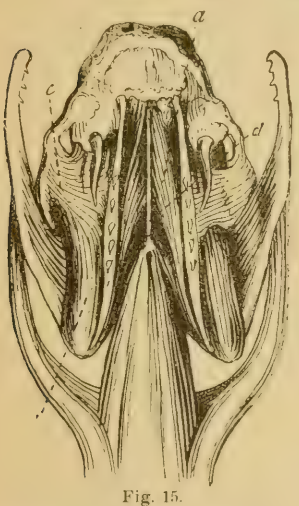


Fig. 15.
MUSCLES OF POISON APPARATUS OF RATTLESNAKE, PALATAL VIEW.
a Spheno-pterygoid muscle; *b* external pterygoid muscle; *c* fascial sheath of this muscle attached to the capsule of the gland; *d* median ridge of base of skull.
(After Mitchell.)

The elevator muscle of the fang is the spheno-pterygoid muscle (fig. 15, *a*), which arises along the median ridge of the base of the skull (*d*), and running backward is inserted upon the enlarged posterior end of the pterygoid bone. The contraction of this muscle pulls (direction *l–m* fig. 16) the pterygoids forward, which thus push the lower end of the maxillary forward, the upper end being held in position by the lachrymal hinge. The tip of the fang describing part of a circle, finally points downward instead of backward. The chief retractor muscle, which antagonizes the elevator muscle by acting in the opposite direction, is the external pterygoid (ecto-pterygoid) muscle (fig. 15, *b*), which arising from the joint between the quadrate bone and the lower jaw, runs forward and is inserted on the outside of the maxillary bone a little below the joint of the latter with the outer pterygoid bone. It will be seen that contraction of this muscle means a pulling backward of the maxillary bone (in the direction *p–e* fig. 16), resulting in the backward and upward movement of the point of the fang.

The fang itself is a large, very pointed, and curved tooth containing two cavities, the pulp cavity and the poison canal, the former situated on the concave side, the latter on the convex side of the tooth (fig. 20). The poison canal has a more or less slit-shaped opening near the base, on the anterior side of the fang, and another slit, narrower and longer on the same side, some little distance from the very sharply pointed tip. Between these openings it is often possible to trace a more or less well-defined depressed line. A microscopic inspection of cross sections of the fang reveals the fact that the canal is nothing but a deep groove, the walls of which have closed over it anteriorly, the depressed line indicating the meeting of the walls, or the "seam." This structure of the fang may be easily understood by comparing it to a leaf curling up in drying, the edges meeting and overlapping in the middle, leaving an upper and a lower opening. By making sections of growing and full-grown fangs of the same individual, the evolution of the grooved fang into the "perforated" fang is easily traced, and the inexactness of the latter term clearly demonstrated. As a consequence of this origin of the canal, it is lined with the same hard layer of dentine as the outer side of the fang, for it will be seen that this inner lining of the canal is in reality the anterior surface, while the outer layer is only the posterior surface of the normal tooth. An inspection of the accompanying figure (fig. 17), which represents a cross section through the upper jaw, with the functional full-grown fang followed by the more or less undeveloped reserve fangs, will show this plainly, as the same principle is involved in the Pit Vipers.

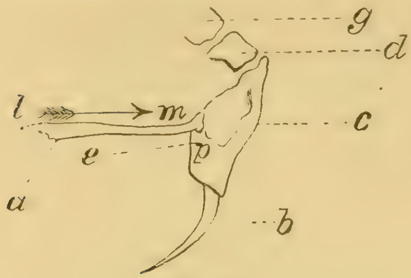


Fig. 16.
DIAGRAM OF THE BONES CONCERNED IN RAISING THE FANG.
a Pterygoid bone; *l m* arrow marking its line of motion; *p-e* external pterygoid muscle; *g* frontal bone; *d* lachrymal bone; *c* maxillary bone; *b* fang.
(After Mitchell.)

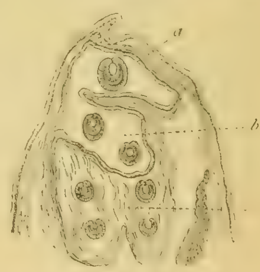


Fig. 17.
ARRANGEMENT OF THE RESERVE FANGS IN BUNGARUS SEMIFASCIATUS, ILLUSTRATING THE DEVELOPMENT OF THE GROOVED FANG INTO THE CANALED FANG. Enlarged.
(After Niemann.)

As already stated, the fang is above fixed firmly in the socket of the maxillary bone, "its base being luted to the portion of the bone around its side and anterior aspect," to borrow Dr. Weir Mitchell's words.* "Posteriorly, the bone possesses a hollow, in which is lodged the tooth sac. In the open mouth of this alveolar process, within the mucous membrane, and upon the pterygoid bone, lie one behind and below another, the reserve fangs, each smaller than the one in front and less

*Researches upon the Venom of the Rattlesnake. Smithsonian Contributions to Knowledge. Washington, 1861, p. 16.

and less developed, until the situation of the last which is visible is marked by a minute papilla alone. I have counted from 8 to 10 of these on each side. When the fang is lost by natural process, it is replaced within a few days; when violently displaced, several weeks sometimes elapse before the next fang is fixed firmly enough to be useful to the snake. If the functional fang be lost or shed, the next tooth gradually assumes its position," and finally, occupying the place of the lost one, becomes anchylosed.

In the same manner as the hollow fang is developed from the grooved fang, and this again from the plain solid tooth, so is the poison gland evolved from the ordinary salivary gland by a specialization of the yellow portion of the latter, as already mentioned under the opisthoglyph snakes.

The typical venom gland is found in its fullest development among the Pit Vipers, and is located on each side of the head below and behind

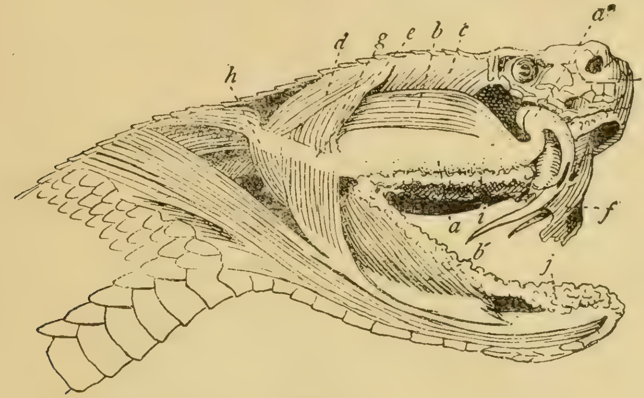


Fig. 18.

POISON APPARATUS OF RATTLESNAKE; VENOM GLAND AND MUSCLES.

Lateral view. *a* venom gland; *a'* venom duct; *b* anterior temporal muscle; *b'* mandibular portion of same; *c* posterior temporal muscle; *d* digastricus muscle; *e* posterior ligament of gland; *f* sheath of fang; *g* middle temporal muscle; *h* external pterygoid muscle; *i* maxillary salivary gland; *j* mandibulary salivary gland.

(After Duvernoy.)

the eye. The shape is that of a flattened almond, the pointed end toward the front and below the eye, tapering to a narrow duct, which carries the poison to the inlet at the base of the fang. The relative size of the organ may best be understood by a glance at the accompanying figure (fig. 18.)

The interior structure of the gland may be described briefly as consisting of a basal cavity into which the small ducts of the glands open. These ducts run toward the walls of the gland, branching, and finally ending in minute blind bags, the whole system of ducts being supported by a network of numerous fine threads and thin sheets of fibrous tissue. The ducts are lined with a more elongated epithelium, the blind pouches with angular nucleated epithelial cells.

The external covering of the gland is made up of two more or less distinct layers of fibrous tissue, the outer one being continued posteriorly in a ribbon-like ligament running backward and inserting itself upon the joint of the jaw (fig. 18, *e*). A short ligament on the side facing the skull attaches the gland firmly to the latter, and a third one below connects with the external pterygoid muscle (fig. 15, *c*).

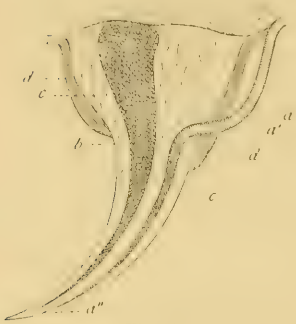


Fig. 19.
LONGITUDINAL SECTION OF POISON FANG OF BOTHROPS

Enlarged. *a* Poison duct entering the fang at *a'*; *a''* opening of poison canal near tip of fang; *b* pulp cavity; *c* dentin; *d* connective tissue.
(After Niemann.)

At the anterior end of the gland the capsule continues as the outer covering of the duct which carries the poison from the gland to the fang. This duct, in its normal position, makes a sudden upward curve (fig. 18, a^1) under the eye, descending from which it follows the posterior wall of the pit and finally passes over the rounded outer front edge of the maxillary bone, at the base of which it meets the upper opening, or inlet, of the canal through the fang.

Until Prof. Jeffries Wyman, in 1860, and, about simultaneously, Dr. Christopher Johnston, published opinions to the effect that the poison duct does not enter the canal of the fang, it was generally held that it actually continued inside of the channel. This latter view has been revived quite recently by Dr. F. Niemann, who not only describes this arrangement, but figures longitudinal and transverse sections of it as seen by him in a crotaloid snake, *Bothrops lanceolatus*.* The longitudinal section is reproduced here as fig. 19, the transverse one as fig. 20. The latter shows at a^1 the poison canal lined with the duct, which, even inside of the fang is characterized by its epithelial lining. As this opens up the question again, and makes future research necessary, and as Mr. Niemann seems to be ignorant† of the investigations referred to, it may be well to quote their evidence a little more fully.

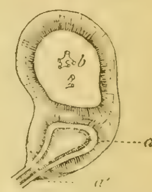


Fig. 20
TRANSVERSE SECTION OF BOTHROPS FANG.

Prof. Wyman's account of some dissections of the poison apparatus of the Rattlesnake was read at a meeting of the Boston Society of

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* Beiträge zur Morphologie und Physiologie der Oberlippendrüsen einiger Ophidier. Wiegmann's Archiv f. Naturg., LVIII, i, pt. 3, Sept., 1892, pp. 262–286 + pl. XIV.

† In spite of the apparent conclusiveness of Mr. Niemann's figures, I am compelled to remark that his paper contains several indications of carelessness which makes it imperative to receive his conclusions with extreme care. That anyone should attempt an investigation of that kind without knowing and quoting Dr. S. Weir Mitchell's epoch-making labors, is scarcely reassuring in the first place, but there seems to be even less reason for a confusion of such terms as Solenoglyph for Opistoglyph on p. 282, and the mistaken identification of the ectopterygoid bone for the maxillary, pp. 277 and 279.

Natural History, May 16, 1860 (Proceedings, Vol. VII; published July, 1860, pp. 293–294), and is quite brief, as follows:

The duct proper does not reach the opening at the base of the tooth, but ends at a short distance from it. The communication beyond this is made by means of the sheath of the tooth, which is too loose to prevent the poison from escaping around the exterior of the tooth instead of entering its canal, were it not for the circumstance that as the tooth is protruded the sheath is crowded back, and thus made to fit tightly the circumference.

Dr. Johnston's statement is much more elaborate, and includes an interesting account of the successive growth and advance of the reserve fangs. It was written by him as early as October 3, 1859, and given to Dr. Weir Mitchell for publication.*

After discussing the probability of a periodical shedding of the fangs and describing the successive formation and growth of the secondary or reserve fangs, Dr. Johnston proceeds as follows:

At length the prime fang is removed, if spontaneously, by the atrophy of the pulp, and, I believe, by erosion of the basal anchylosed portion; if it be broken off by violence the freedom of the pseudo-socket is accomplished by the same means. And now the first tooth of reserve is urged forward into a recess in the maxillary bone directly adjacent to and on the inner side of the fallen fang; and the requisite advancement is brought about by the developmental *vis à tergo* of the remaining reserve pulp, and probably also by the traction in front exerted by the cicatrizing parts. It is evident that the fang emerges from its capsule, and that the point and crown repose in the den, but the base is closely invested with the capsular remains under the form of a periosteal expansion, which is the mediate bond of union between the base and the new and shallow socket of the maxilla.

As may be perceived upon examination at this stage, two sockets coexist in the same jaw, the inner, new one, supporting the recently promoted fang, and the outer, old, and now vacant one, which is fast becoming disencumbered of the vestiges pertaining to its former resident. In this maxilla the new fang occupies the innermost part, having the old socket on the outer side, while in the opposite maxilla, the older venom fang may be discovered in its normal situation, leaving the recess to its inner side vacant for the temporary lodgment of its successor. Or, both fangs being recently fixed to the jaw, the vacuities will both be formed on the outside, and all the reserve fangs will appear to follow backward and outward in direct line.

Now, let us look at the situation of the poison duct and examine into the mode by which it is brought into relation with the fang.

The venom duct arising from the gland makes a bend upward, immediately beneath the eye, then advances forward under the skin as far as the crotaline fossette [pit], and lying upon the maxilla externally, plunges downward, and pierces the gum in front of the fang, where it terminates in a papilla, which projects slightly into the proximal aperture of the tooth. In this position it is maintained by the gum, which clasps the base laterally and in front with considerable firmness, its inferior or distal edge encompassing the annular enlargement already alluded to. Nor is there any other than a mediate application of the poison papilla against the fang, for, as the whole venom canal of each tooth is really upon the outside of the organ, no special membrane lines it, which might be continuous with the duct that discharges into the upper aperture.

Such is the condition of things in an old fang, occupying its normal exterior position. But when the tooth drops out, or is broken, the gum is left entire; or, if its

*Researches upon the Venom of the Rattlesnake, pp. 17–19. (Published January, 1861.)

exodus has been forced, the gum escapes with laceration only. In either case, however, the gum remains as a barrier, limiting the progress of the advancing reserve fang; and while the latter is establishing itself provisionally the gum encircles it, clasps it tenaciously, and brings the poison papilla in opposition with its dental aperture. As time passes, the new fang moves gradually outward to its permanent seat; the inner maxillary recess is restored, and the first fang of reserve is again discovered on the inner side of its senior, resting with its pulp attachment in the bottom of the recess. Thus, the reserve fang has become an adult functioning fang, nor does its pulp relax its hold until fate or mischance dislodge the now fatally-armed tooth which it animates.

Dr. Mitchell adds that although it is often, or usually, the case that, as stated by Dr. Johnston, the first reserve fang enters the semilunar socket in the maxilla to the inside of the active fang, it is not uncommon to find the two fixed fangs unsymmetrically placed, one on the inner, the other on the outer side, of their respective sockets, or both on the inner side; or again, both on the outer side. He also expressly states that in all other points his own researches agree with those of Dr. Johnston, and he presents the diagram, here reproduced (fig. 21), to illustrate their views as to the direction taken by the new fang in its progress toward the alveolar socket.

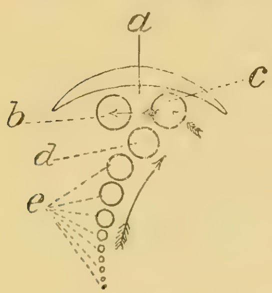

Fig. 21.
DIAGRAM ILLUSTRATING THE SUCCESSION OF THE FANGS.
a Alveolar socket; *b* functionary fang; *c* its successor; *d* the next fang in order of age; *e* remaining germs.
(After Mitchell.)

I have previously mentioned the special muscles engaged in erecting and depressing the fang. I shall now call attention to those which force the poison through the duct into the hollow fang.

In the non-poisonous snakes the closing of the mouth is effected by the three temporal muscles, the anterior, the middle, and the posterior. The anterior temporal arises from the parietal crest and its continuation on the postfrontal bone, turns backward around the joint of the lower jaw and is inserted on the latter bone; the middle temporal arises from the posterior half of the parietal crest, runs downward and forward under the former and is similarly inserted, while the posterior temporal, the strongest of them all, arises from the quadrate bone and is inserted on the inside of the entire length of the angular bone of the lower jaw.

In the crotalids this arrangement is considerably modified (fig. 18). The posterior (*c*) and middle (*g*) temporal muscles remain essentially as in the non-venomous snakes, and their function is also the same, viz, by contraction to pull the lower jaw up against the upper one, or, in other words, to close the mouth. The anterior temporal (*b*), however, has now both a different rise and a different function. Instead of connecting with the cranial wall, it has lost all connection with the latter and arises from the upper posterior portion of the firm, tendinous capsule of the poison gland (*a*), runs backward under the ribbon-like ligament (*e*) which fastens the gland to the joint of the jaw, winds

around this joint and inserts itself (b^1) broadly upon the lower jaw. It may easily be shown that a contraction of these muscles will produce a tremendous pressure upon the poison gland. It is also apparent that the closing of the mouth does not necessarily affect the gland, as only the posterior and middle temporals need be employed in the action, and that the pressure exerted by the anterior temporal is voluntary, as well as independent of the closing of the jaw.

While thus the flow of poison is regulated by the pressure upon the gland, there are additional safeguards against waste of the precious fluid. Dr. Weir Mitchell has discovered that the visible thickening of the poison duct anterior to the sudden turn under the eye is due to an increase in the amount of the fibrous tissue of the walls, and not to any widening of the canal. As he also found the walls of the duct at this place to contain nonstriated muscular tissue, he concludes that the enlargement is a real ring-muscle, or sphincter, which by its contraction closes the duct, and he demonstrated the correctness of his conclusion by experiments. He found that when in the living and active Rattlesnake the jaws were separated, and the fangs caught on the edge of a cup and erected, it was usually very difficult to produce a flow of venom against the will of the snake, even when the operator pressed upon the glands, but that on the contrary it was easy to force the poison out along the duct and through the fang, if the snake was dead or insensible from chloroform.

The whole poison apparatus has very appropriately been compared to a hypodermic bulb syringe, the needle, with its obliquely cut point and slit-like outlet, representing the fangs, the bulb corresponding to the poison glands, and the muscles of the hand which presses the bulb performing the same task as the anterior temporal muscle.

The nature of the poisonous fluid secreted by the gland in the pit vipers seems to be almost as diagnostic as the apparatus itself. The discussion of its properties is so closely connected with the question of antidotes and remedies that a summary of the interesting results of Drs. Mitchell and Reichert's recent studies and discoveries in this field will be reserved for quotation in the closing chapter of this paper, and I shall now devote some space to the action of the snake in utilizing the formidable weapon which has been described.

The action referred to is not a "bite" pure and simple, it is the combination of a bite and a blow delivered with such lightning rapidity that it is very difficult, if not impossible, for the unaided eye to follow the various movements composing it and to record their occurrence in the proper sequence. The testimony furnished by our eyes as to the movements and sequence involved in an action as familiar and comparatively slow as that of a running horse was proven utterly false by the instantaneous photographs, and it is very likely that there are similar surprises in store for us when some one shall have rigged up a "battery" of cameras and fixed the successive movements of the striking

Rattlesnake on paper in such a manner as to leave no more room for guesses, interpretations, and disputes.

How desirable such a series of pictures is may well be understood by a reference to an extended discussion which was carried on in the well known New York weekly, Forest and Stream, about two years ago. In the issue for May 26, 1892,* the editor called attention to a statement by the greatest herpetological authority in the country with regard to the action of the Rattlesnake, and which the editor characterizes as "very extraordinary." The statement is to the following effect:

> The species of this genus [*Crotalus*] are of rather sluggish movements, and are not quick to bite, unless trodden on. They throw the body into a coil and sound the rattle, giving a sigmoid flexure to the anterior part of the body, on which the head is poised with open mouth ready for action. At this time drops of the poisonous saliva fall from the fangs, and by a violent expulsion of air from the lungs are thrown at their enemy.†

It is evidently the last half of the account which called forth the criticism and led the editor to call upon the readers "to contribute some evidence on the point in question." In the very next number two observers controvert the statement in decided language. Few men are such keen observers or have had such opportunities for observation as Maj. Charles E. Bendire, from whose reply‡ we quote as follows:

> During a residence of more than twenty-five years in the western portion of the United States, a considerable part of this time having been spent in the field, where Rattlesnakes were and are still common, and during which time I have seen hundreds of these reptiles, I have never yet observed one with its mouth open when coiled and ready to strike; neither have I ever seen one attempt to throw poison, even when teased and much provoked.

The other reader, who signs himself J. M. W., and who evidently has had some experience with Rattlers, concludes § a similar protest with the following statement:

> While living in southern Illinois I had a captive nearly 5 feet long—a vicious fighter, who would strike at any object thrust toward him, and often caught his curved fangs in the fine wire netting covering the cage, thus holding his open mouth in position for a fraction of a minute. The venom from each fang, a light amber-colored fluid in drops about the size of No. 6 shot, could be seen on the gauze where it collected when he struck, but there was nothing more, no saliva, no spitting or hissing, nor have I ever seen these manifestations in any of the many individuals that have come under my immediate notice. Nor have I ever seen a snake's mouth open, with fangs exposed, while waiting a chance to strike. When they strike, the jaws open at an angle of nearly 180 degrees, but not until the final moment.

In the next issue is a very interesting note by Dr. M. G. Ellzey,|| from which the following sentence is quoted:

> I have seen Rattlers in coil, and seen them strike from coil very often, but never saw one holding its mouth open, with erect fangs, dripping poisonous saliva.

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* Forest and Stream, XXXVIII, p. 493.

† Proc. U. S. Nat. Mus., XIV, 1891 (No. 882), p. 687.

‡ Forest and Stream, XXXVIII, June 2, 1892, p. 518.

§ Forest and Stream, loc cit.

|| Forest and Stream, XXXVIII, June 9, 1892, p. 538.

For several weeks similar accounts, some, however, more or less mixed with decided "snake stories," appeared in the columns of the paper,* with one exception, that of "E. D. W. S." (June 16, 1892, p. 562), whose experience in California with a "Black Rattler," which "arched his head and neck and hissed or blew quite a quantity of *froth or spittle*," seems to prove nothing, as it proves too much. The discussion was finally concluded by Prof. E. D. Cope, who disclaimed having represented in the paragraph criticised the normal action of the rattler when ready to strike, as the following quotation† shows:

I did not state that Rattlesnakes always maintain the position described when about to bite. On the contrary, it is only when prevented from either biting or running away that they act in the manner mentioned. If a Rattlesnake is annoyed by being stirred up with a stick and pebbles, etc., thrown at him, and is prevented from escaping, if he is in good condition and the weather is warm he will sometimes act as I have stated from actual observations made on the *Crotalus confluentus* in New Mexico. When the mouth is opened widely, the masseter muscle compresses the poison gland,‡ and, if the latter is full, forces some of it to escape through the duct, and it drops from the fangs. This is an observation which has been often made on various venomous snakes. If the snake expels air from the lungs in hissing, as it generally does when on the defensive, the drops will be thrown out with the air toward the enemy. I do not suppose, and did not state, that this was done voluntarily by the snake; it is simply a necessary consequence of the mechanical conditions.

I have reviewed this controversy so fully because it shows the necessity of an authoritative account of the *normal* action of the snake when striking. During the discussion one writer quoted a few disconnected passages from Dr. S. Weir Mitchell's elaborate article on the subject, but as a clear understanding of the action involved can only be gained from a detailed account, I have no hesitation in reprinting nearly the entire chapter devoted by the famous specialist on the rattlesnake and its poison, especially because the original is now out of print, and there is no other account equaling it in accuracy and clearness, and there is not apt to be much added to it or corrected in it until we shall have the series of photographs alluded to above. His account is published in the third chapter of his "Researches upon the Venom of the Rattlesnake" (published in 1861 by the Smithsonian Institution as one of the Smithsonian Contributions to Knowledge), entitled "The Physiological Mechanism of the Bite of the Crotalus," and is to the following effect: §

When the Rattlesnake is in repose and unmolested, it sometimes lies at length, sometimes coiled or wrapped fold on fold in the loops formed by other snakes which

* "M. E. J." and "Whippoorwill," June 16, p. 562; S. D. Kendall, George H. Wyman, and "W.," June 23, p. 588; "Barker," June 30, p. 610.

† Forest and Stream, XXXIX, August 11, 1892, p. 114.

‡ The masseter muscle is the same as is above called the temporal muscle. It is difficult to see how in opening the mouth this muscle can compress the poison gland. This can only be done by a contraction of the muscle, but this contraction must necessarily close the mouth.

§ Pp. 20–25.

may happen to be in the same box. So soon, however, as cause is seen for alarm, the snake extricates itself, if among others, and at once throws its body into the coil so familiar to any one who has seen serpents, whether venomous or not. Sometimes on the edge, more often in the center of the coil, the tail projects far enough to admit of its vibrating freely and with singular swiftness. The head is raised a little above the rest of the body, but not usually more than 3 or 4 inches, even in large snakes. The neck and upper end of the trunk are not thrown into complete circles, but lie in two or three abrupt curves across the mass of the coiled body. The snake is now in position to strike. While thus at bay, in an attitude of singular grace, the long black tongue is frequently protruded—a common movement among all serpents when irritated. Just before the blow the snake makes a hissing sound, which is caused by the act of expiration, and is due to the passage of air through the narrow glottis. It is louder in certain innocent serpents than in the crotalus.

The mechanism of the forward cast of the body, which next occurs, is a very simple matter. The muscles which lie upon the convexity of the bending formed by the upper part of the snake are suddenly and violently contracted, so as abruptly to straighten the body, and thrust it forward in a direct line. The force resulting from this motion is not very great, as I have often ascertained when a snake has struck the end of a pole which I was holding, nor could it alone suffice to bury the fang in a tough skin were it not for the acts which follow and aid it. In effecting this forward thrust of the neck and head the serpent employs only the upper part of its body, and consequently is unable, under any circumstances, to strike at a greater distance than one-half its length, while usually its projectile range does not exceed a third of its length. An impression prevails that when the snake lies coiled its head is raised very high to enable it to strike downward. It seems, however, to be of no moment in what direction the danger threatens, since it can at will cast itself forward, downward, or almost directly upward.

As the animal comes within reach, of which the snake does not always judge with accuracy, the latter executes the movement just described. At the instant and while in motion the jaws are separated widely and the head is bent somewhat back upon the first cervical bones, so as to bring the point of the fang into a favorable position to penetrate the opposing flesh. Owing to the backward curve of the tooth, this of necessity involves the opening of the jaws to such an extent that an observer standing above the snake can see the white mucous membrane of the mouth as the blow is given. The peculiar articulation of the lower jaw upon an intermediary bone in place of upon the body of the skull greatly facilitates this action. On examining the neck and head it will also be seen that the head, under the influence of the cervical prolongation of the mass of the spinal muscles, is capable of being bent backward to no inconsiderable extent. Consentaneously with the forward thrust of the body and with the opening of the mouth the spheno-pterygoids act from their firm cranial attachments to draw forward the pterygoid plate, and thus, through its attachment to the maxillary, to erect the fang. The function of elevating the fang belongs alone to this muscle, which has no analogue in the other vertebrate animals. I have frequently tested its power to raise the fang by stimulating it with galvanic or other irritants, after decapitating the snake, and, although some French observers seem to have had doubts as to the agencies which effect the elevation and depression of the fang, there does not seem to me to be any reason to doubt the share which the spheno-pterygoid takes in this mechanism. That the mere act of opening the mouth of necessity raises the weapon has often been affirmed, but it is only necessary to separate the jaws of a crotalus to be convinced that this is not the case, and that even when the mouth is widely opened the animal has the most perfect control over the movement of the fang, raising or depressing it at will.

As the spheno-pterygoid acts, the maxillary bone rocks forward upon its lachrymal articulation. When the motion reaches its limit, and is checked by the ligament which I have described, the supporting lachrymal bone, in turn, yields to the

power applied through the maxillary bone. These movements elevate a little the muzzle of the snake, so as to give to the face a very singular expression during the act of striking. Their more obvious and important result is the elevation of the fang, which, rising, thrusts off from its convexity the cloak-like vagina-dentis so that it gathers in loose folds at its base (fig. 22.)

As the unsheathed tooth penetrates the flesh of the victim a series of movements occur, which must be contemporaneous, or nearly so. The body of the snake, still resting in coil, makes, as it were, an anchor, while the muscles of the neck contracting draw upon the head so violently that when a small animal is the prey it is often dragged back by the effort here described. If now the head and fang remained

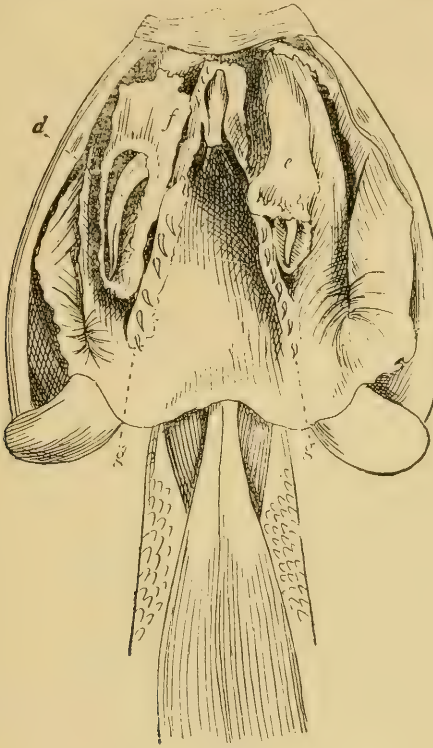

Fig. 22.

PALATE OF THE RATTLESNAKE.

d Fang; *e* sheath (vagina dentis) covering the fang; *f* sheath thrown back so as to show the fang; *g* palatine teeth. (After Duvernoy.)

passive the pull upon the head would withdraw the fang too soon; but at this moment the head is probably stayed in its position by the muscles below, or in front of the spine; while the pterygoideus externus and spheno-palatine acting upon the fang through their respective insertions, into the posterior apophysis of the submaxillary bone, and the inside of the palate bone, draw its point violently backward, so as to drive it more deeply into the flesh. The muscles alluded to, therefore, antagonize the spheno-pterygoid. At this instant occurs a third series of motions, which result in the further deepening of wound and in the injection of the poison. The lower jaw is closed upon the bitten part or member. Where the surface struck is flat and large this action will have but slight influence.

Where the jaw shuts on a small limb or member, the consequent effects will be far more likely to prove serious, since the power thus to shut the mouth materially aids

the purpose of the blow. The closure of the jaw is effected by the posterior, middle, and anterior temporal muscles. The first two tend simply to shut the mouth; the anterior temporal, however, is so folded about the poison gland that while it draws up the lower jaw it simultaneously compresses two-thirds of the body of the gland. This force is applied in such a manner as to squeeze the fluids out of the upper and back parts of the gland and drive them forward into the duct. The anterior lower angle of the gland, as well as a portion of the duct, is subjected to similar pressure at the same instant, owing to the flat tendinous insertion of a part of the external pterygoid upon the parts in question.

It will thus be observed that the same muscular acts which deepen the wound fix the prey, and inject the venom through the ducts and into the tissues penetrated by the teeth. The whole process here described at such length is the work of an instant, and the serpent's next effort is to disentangle itself from its victim. This step is effected by relaxing the muscles of the neck so as to leave the head passive, while the continued traction of the muscles of the body pull upon it, and thus withdraw the fang, over which glides the elastic mucous sheath as the pterygoid, again acting, depresses the fang, and the serpent recovers its posture of defense.

It happens, not infrequently, that the teeth of the lower jaw catch in the skin of the bitten animal, and thus prevent the snake from retreating at once. When this takes place the serpent shakes its head from side to side with a motion which so nearly resembles the shake a dog gives its prey that it has been mistaken by at least one observer for an expression of rage. It is really an attempt to escape; nor is it always successful, since a large animal will often drag a snake until the fangs themselves break loose and are left in or on the bitten part.

In considering this portion of our subject it is well to notice what has been too much overlooked, the fact that, while the snake commonly employs both fangs, it does often inflict but a single wound. When obtaining venom from living snakes, I have been accustomed to allow them to bite upon the inner edge of a cup, and I have observed that on some occasions both fangs were used at once, and that on others only one was active. Or, the fangs were used in succession, an appreciable interval of time intervening. If this occur when a snake at freedom strikes an object, it is, of course, possible that the animal may escape before the second fang is driven in by the traction of its proper external pterygoid muscle. At all events, it is certain that these facts should receive due appreciation in estimating the danger of a given bite and the value of an antidote.

There remains for consideration one muscular motion, which I have observed to accompany the effort to bite when the snake is held by the back of the neck. It consists in a turning outward of the points of the fangs, so as to separate them from one another.* This divergence of the fang points is disadvantageous, inasmuch as it causes them to enter somewhat obliquely, and frequently throws one fang beyond the part bitten, when that part happens to be small. It has a use with reference to the snake itself, since the fang points, when thus widely separated, lie oustide of the lower jaw, and are thus prevented from wounding it. This purpose is greatly aided by the action of a muscle analogous to the mylo-hyoid, which approximates the anterior extremities of the lower maxillary, or mandibular bones, so as to make narrow the extremity of the jaw. The protection thus obtained is very essential, since the serpent always closes the jaw violently when biting, but does not always succeed in seizing its prey. Whether or not this divergence of the fang points occurs when the snake bites unrestrainedly, I can not say, but as I have been very often astonished at the distance between the wounds, when both fangs had taken effect, it is highly probable that it occurs under all circumstances.

The power with which the venom is ejected from the tooth depends somewhat upon the amount contained in the gland and its ducts. When the snake fails to

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*I could not determine whether this divergence took place when the snake, at freedom, struck an animal.

strike the object aimed at the poison is sometimes projected several feet. In one case which is known to me, it was thrown into the eye of a man standing 5 or 6 feet from the snake, when it struck upward at a stick held above its coil.

The study of the complicated mechanism which we have endeavored to explain will aid us in understanding several points of interest in connection with the bite of the rattlesnake.

It must be perfectly apparent that in a sequence of movements so elaborate it will occasionally happen that, from a failure in some one of the essential motions, the ultimate purpose of the whole will be interfered with. Thus, it sometimes chances that the serpent miscalculates the distance, and fails from this cause. Or, again, when the object aimed at is very near, the initial force of the blow is lost, and the tooth does not enter; no uncommon occurrence, where the animal struck is an old dog with a tough skin. Again, if the upper jaw be not elevated sufficiently, the fangs are sometimes driven backward, by the force of the forward impulse, as they touch the part attacked, and the venom is then apt to escape between the tooth and the covering mucous cloak. Upon one occasion, having allowed a small snake to strike a dog, the former became entangled, owing to the hooked teeth of the lower maxillary bone having caught in the skin. Upon examining the snake closely, the dog being held, I found that the convexity of the fangs lay against the skin, on which were thrown one or two drops of venom. On removing the snake, and inspecting the part struck, I could find no fang wound, although the skin was visibly torn by the smaller teeth. I have seen the rattlesnake strike with great apparent ferocity, a number of times, when I have been unable to discover any fang wound whatsoever, and this has taken place, occasionally, with small animals, such as the rabbit, which must have been seriously effected by even a small amount of venom.

It scarcely ever happens that an animal is bitten without a part of the injected venom being cast on the skin near the wound made by the fangs. This wasted material probably escapes from the duct, where it is in opposition with the lower opening of the fang canal, and may be merely that excess of fluid which the fang can not carry. In some cases, however, it is quite possible that the relations of the fang and the duct are so disturbed that the venom never enters the tooth at all. It is certainly true, as has been already stated, and as Dr. Wyman has shown, that the fang must be fully erected in order that the duct shall be so firmly held in contact with the fang, as to insure the passage of the venom through this latter organ.

Finally, it sometimes happens that the blow is given, the fang enters, and from the quick starting of the animal injured, or from some other interrupting cause, it is withdrawn so soon that the larger portion of the poison is thrown harmless upon the surface near the wound. Under these circumstances, the resulting symptoms are, of course, trifling, and how well such an occurrence would be calculated to deceive the observer, who employed an antidote in a like case, can be readily conceived.

In a more popular paper* Dr. Mitchell remarks that the nervous mechanism which controls the act of striking seems to be in the spinal cord, for if we cut off a snake's head and then pinch its tail the stump of the neck returns and with some accuracy hits the hand of the experimenter if he has the nerve to hold on. A little Irishman who took care of the doctor's laboratory astonished him by coolly sustaining the test, but did it by closing his eyes and so shutting out for a moment the too suggestive view of the returning stump. In the memoir previously quoted, on the other hand, he mentions that in one or two instances persons who were ignorant of the possibility of this movement have been so terrified at the blow which has greeted them as to faint on the

*Century Magazine, XXXVIII, August, 1889, pp. 503-514.

spot. The educated public which has seen so many wonderful tales concerning snakes disproved have in turn become skeptical about almost everything told about them not of the most commonplace character. Hence, the somewhat ironical introduction to the following story, which made its round through the daily press of the country, and which is no doubt correct in every particular:

Prof. Brewer, of Yale, recently told a good snake story. Years ago he was in California and had his tripod and other surveyor's instruments in the field. Stepping along in the bushes he felt a movement under his feet, and found that he was standing on a 4½-foot Rattlesnake—a large, vicious and fighting fellow. But the snake was so pinioned that he could not strike the thick boot that held him fast. Prof. Brewer held the rattler's head down with his tripod and cut it off. Then he cut off his rattles. Stepping aside, he saw the body of the snake, partly coiled, lying very still. Taking out his rule to measure its length, the professor took hold of the serpent to straighten him out.

"Quick as an electric shock," said Prof. Brewer, "that headless snake brought the bloody stump over and struck a hard blow upon the back of my hand." He added: "I knew that his head was off and that he could not poison me, but that quick and hard blow of the rattler made my hair stand on end."

However, the most dramatic incident of this kind is undoubtedly Mr. George Catlin's adventure on the Rio Trombute, one of the tributaries of the Amazon River in South America. The story as told by Mr. Catlin's companion * is to the effect that Mr. Catlin having shot at the head of a huge Rattlesnake had apparently missed it, as the snake was seen to strike and hit him in the breast, where it left a bloody spot on the shirt. The dress was torn open and one of his half-breed companions prepared to suck the poision out of the supposed wound; but looking a moment for the puncture, he got up, and with a smile of exultation he said, "There's no harm; you'll find the snake without a head." In the weeds near-by the snake was found, closely coiled up, where he had fallen, with his headless trunk erect and ready for another spring, the head having been shot off.

If we make some allowance for the necessarily high coloring of the narrative and the exaggeration almost inseparable from an account of an occurrence so strange and exciting, there seems to be no good reason to doubt that it took place in the main as related.

Beyond the "pit" there is but little to distinguish the Pit Vipers as a whole from the other vipers, and, beyond the poison apparatus and the changes in the various organs of the head directly or indirectly connected with this apparatus, they differ not materially from the bulk of the snakes. One group of the pit vipers possesses, however, an organ quite unique, not only among the vipers, but among all the snakes as well, so that it seems the better plan to treat of it in the present connection instead of later on under the head of that particular group. I refer to the "rattle" of the Rattlesnakes.

* See Catlin's, "Life amongst the Indians" (New York; Appleton & Co., 1867), pp. 247–249.

It may seem superfluous to describe this well-known instrument in detail, but as the internal structure may not be clear to everybody, and as without such a knowledge it will be difficult to explain the development and use of this organ, we are obliged to investigate it more closely.

It will be seen (figs. 23, 24) that the tail end of the Rattlesnake instead of gradually tapering to a point covered by a cone-shaped more or less

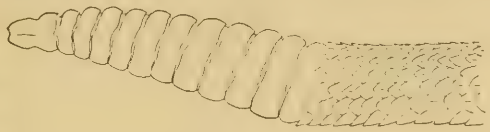

Fig. 23.
PERFECT RATTLE OF A LARGE BANDED RATTLESNAKE.
Side view. Three-fourths natural size.
(After Garman.)

acute scale, as in most other snakes, continues rather thick to where the rattle is appended. The rattle itself in its perfection is shown in the above figures, and appears externally to consist of a series of strongly compressed horny rings joined rather loosely together, the terminal one, the so-called "button," ending in a compressed, somewhat cone-shaped cap, which is set off from the basal swelling by a slight constriction.

Fig. 24.
LONGITUDINAL SECTION OF RATTLE.

The upper and lower outlines of the rattle will be seen not to be straight but curved lines, the tendency of the joints to sag downward by their own weight being counteracted by the fact that the width of each ring is greater at the lower edge of the rattle than at the upper. Mr. Quelch, the director of the museum in Georgetown, Demerara, has shown that the object of this arrangement is to protect the rattle

Fig. 25.
SEPARATE SEGMENTS OF DISJOINTED PERFECT RATTLE OF CROTALUS.
Side view.
a button; *h* basal joint.
(After Czermak.)

against injury and moisture when the snake is moving over the ground by keeping the somewhat delicate instrument automatically raised.

In order to study the internal structure of the rattle so as to learn how the various joints are linked together we will have to either pull them apart separately (fig. 25) or make a longitudinal section through

the organ (fig. 24). It is then seen that each "ring" is in reality a "button" that fits over and conceals the terminal portion of the foregoing (proximal) joint, leaving exposed only the basal swelling, the ring. The joints are consequently a series of partly overlapping thin horny capsules or "cones." These "cones" have a wavy outline consisting of two or three swellings and two constrictions. It will also be observed that the free edge of the cone is bent inward and fits into the basal groove of the preceding cone, so that the basal swelling of the more distal cone clasps around the second swelling of the one nearer the body. The opening being narrower than this swelling, the two cones are effectually linked together by means of a kind of restricted ball-and-socket articulation, modified by the shape of the joints.

It will furthermore be noted, upon actually dissecting the tail end of the body, that the basal cone of the rattle forms the horny cover of a strong thickening of the skin which, in turn, envelops a more or less cone-shaped compressed bone. This bone terminates the vertebral column, being in fact the 7 or 8 last vertebræ enlarged and fused together into one.

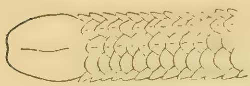

Fig. 26.
TAIL END OF EMBRYO OF MASSASAUGA.
Side view. Three times natural size.
(After Garman.)

Upon this dermal thickening surrounding the terminal bone, the epidermal horny capsule is evidently formed. The latter, in the same manner as the rest of the epidermis in the snakes, in the course of its growth becomes detached from the secretory layer, and a new epiderm is formed beneath it, but while on the rest of the body this renewal of the outer skin results in the well-known process of sloughing, the peculiar shape of the horny capsule of the end of the body and its greater thickness and strength prevents its slipping off in the same manner. It is consequently pushed out from the end of the tail closely clasping around the median constriction of the new cone which now appears externally as the basal "ring."

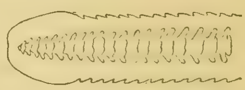

Fig. 27.
DIAGRAMMATIC LONGITUDINAL SECTION OF FIG. 26.

Prof. Samuel Garman has carefully worked out and beautifully illustrated the successive stages of the growth of the rattle from the first indication in the embryo to the perfected organ in the full-grown snake, and from his paper * the following account is mainly taken:

In very early embryos of the Ground Rattlesnake, *Sistrurus miliarius*, some of them already 3 inches long, the tail was not yet furnished with scales, though the entire body was well provided. Outwardly the tail was short, thick, blunt, slightly compressed, but with no indication of the characteristic feature so prominent after birth. Embryos of a nearly allied species, the Massasauga, *S. catenatus*, however, which were older and twice as large, showed a distinct promise of the future rattle in the shape and size of the terminal cap, or button (figs. 26, 27),

*The Rattle of the Rattlesnake. Bulletin Mus. Comp. Zoöl. Harv. Coll., XIII, No. 10, pp. 259–268, pls. I, II. August, 1888.

which is as yet incomplete and but little more than half what it ultimately becomes. There are now scales on the tail, but they show no fusion with the button around its front border. Within the button the vertebræ are still distinct and surrounded by muscle. The next step is illustrated by one-week-old young ones of the same species (figs. 28, 29), 8½ inches in length, which show a decided gain, the externally visible

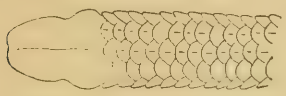

Fig. 28.
TAIL END OF ONE-WEEK-OLD MASSASAUGA.
Side view. Nearly three times natural size.
(After Garman.)

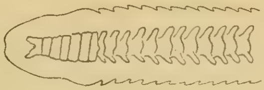

Fig. 29.
DIAGRAMMATIC LONGITUDINAL SECTION OF FIG. 28.

part of each ring having been now acquired. In no case is there any disposition on the part of the scales to fuse with the button. Inside of the latter the changes have been even greater; the vertebræ, still plainly outlined, have consolidated into a single elongate mass, the size of which is being increased by both lateral and terminal growth; the vertical processes have grown together; and the muscles have been displaced by the enlarging bone and the thickening skin. Figs. 30 and 31 finally show us the status of a 14-inch-long Prairie Rattlesnake,

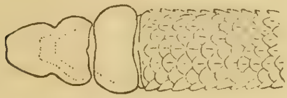

Fig. 30.
INCIPIENT RATTLE OF YOUNG PRAIRIE RATTLE-SNAKE.
Side view. 1½ natural size.
(After Garman.)

Fig. 31.
DIAGRAMMATIC LONGITUDINAL SECTION THROUGH FIG. 30.

Crotalus confluentus, which was taken, with the third button about half grown, when the process of pushing back the second ring was well under way. The first ring had been set free with the first slough, holding only by the collar, and if the snake had been allowed to live a little longer, the second sloughing would have discovered the third button perfected, clasped by the second ring, the latter pushed back and loosened from the balance of the epidermis.

It should be added that the period of appearance of the first joints seems to vary, inasmuch as there are apparently trustworthy records of embryos having been found with more than one joint.* It is interesting, in this connection, to remember Dr. Hay's observation that hognose snakes commenced to shed their skin within a few minutes after having left the egg.† As the young Rattlesnake leaves the egg covering before being born, may it not also occur that it sheds its skin before birth—at least, sometimes?

* Hopley, Snakes, 1882, p. 299.

† Proc. U. S. Nat. Mus., xv, 1892, p. 394.

How hard it is to overcome a popular error which has once taken hold of the public mind is strikingly exemplified in the matter of the growth of the rattle. It was observed long ago, and commented upon by competent observers and scientists, that the common belief that each ring on a Rattlesnake's rattle represents a year of its life, and that its age consequently can be ascertained by simply counting the number of rings, is entirely erroneous. Still, the belief is so common that every scientific writer who treats of Rattlesnakes finds it necessary to repeat the (in print) threadbare denunciation of this fallacy, but evidently without the slightest effect so far as the general public is concerned, for the next newspaper report of the latest Rattlesnake killed in the neighborhood, and the newest edition of certain "popular" natural histories, repeat the same old fallacy. I do not expect to have better success than my predecessors in this respect, though it would not seem to be difficult to make people understand that the rattle is a delicate instrument which easily breaks; that old and huge Rattlers are often found with but one or a few rings; that a variable number of joints are added each year; and that the production of a ring can be accomplished in the course of every two or three months.

On the other hand, it is often asserted by good scientific authorities that a new joint is formed at each general sloughing of the skin. Schlegel* seems to have been the first to suggest this idea, which has been indorsed, among others, by Garman, who says (*op. cit.*, p. 259) that the Rattlesnakes differ from other snakes "in retaining a portion of each slough, that covering the tip of the tail, to form one of the rings of the rattle."

It has already been shown that the formation of the rings, or buttons, is a process of sloughing analogous to, or rather identical with, that of the rest of the outer skin, but this does not necessarily imply that the sloughing takes place at the same time, or that a new button is formed every time a sloughing of the skin takes place. Recent observations by a prominent Russian investigator, Dr. A. E. Feoktistow, seem to indicate that the two processes are, to some extent at least, independent. His conclusions are sufficiently important to warrant the following quotations from his paper: †

In June, 1887, I received ten living specimens of *Crotalus durissus*, which I have since been able to observe closely. Owing to want of a sufficient quantity of suitable food (the animals refused to eat anything but very young rabbits), I lost five of them in the course of the first six months. The remainder are in good condition, and now (August 16, 1888) devour birds in addition to rabbits. They live in a large terrarium provided with a spacious water reservoir, cement floor, and a permanent hot-water heating apparatus which renders it possible to maintain the temperature of the air in the interior at 20° to 22° R (=77° to 81.5° F). The snakes are provided with living food in sufficient abundance, and are equally lively in winter and summer.

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* Essai sur la physionomie des serpens, 1837, II, p. 557.

† Zur Physiologie der Klapper des Crotalus durissus. Bull. Acad. Sc. St. Pétersbourg (n. s.) I, 1889, pp. 1–4. Also in Mél. Biol. Acad. Sc. St. Pétersb., XII, livr. 1, 1891, pp. 1–4. Translated in Ann. Mag. Nat. Hist. (6) XI, Jan., 1893, pp. 54–58.

This opportunity has enabled me to make accurate observations upon the growth, falling off, and renewal of the rattle. I am in the fortunate position of having been able to make certain observations upon healthy specimens with good appetites, which decide these questions.

In five of my snakes the long rattles fell off independently at different times, and I was now able especially to observe how rapidly these redevelop. I would first, however, remark that it is perfectly natural for the rattle of the Rattlesnake to fall off periodically or at irregular intervals, for the organ in question consists of dead, horny tissue, developed into the well-known hollow "cones," which, while partly inclosing one another to form the rattle, are yet only somewhat loosely connected together. Now, it may be readily understood that such a series of links, when it attains a certain length, is greatly exposed to mechanical injury, and, consequently, may easily break off. Without any harm to the snake itself, this chain may be also cut off or torn off by force. This is, indeed, the simple reason why the rattle never becomes particularly long, and rattles with 15 to 18 joints are rare. As a rule, the rattle only lasts long enough to become 8 or 9 jointed.

As I have already stated, I was able to follow the reproduction of the rattles in the case of five of the Rattlesnakes which had lost these organs. So long as their rattles remained short, the snakes were naturally also unable to make a noise. But the joints were gradually replaced, and in such a way that in all cases, in the course of from three to four months, two new ones were added to the remaining (now terminal) joint. Three-jointed rattles like these produced already a fairly loud sound. In the course of a year the rattles developed into chains with from 5 to 6 joints, and were then capable of producing the usual intense rattling sound. The reproduction of the rattles had no connection with the recurring sloughing of the skin. It is well known that the epidermis is shed without the rattle, separating close to the margin of the latter, and, indeed, in such a way that the end of the tail in the cast skin is represented by an aperture with finely notched edges corresponding to the rows of scales.

It consequently follows from my observations that a joint of the rattle can be produced in the course of every two to three months (during winter, autumn, and spring, of course by means of artificial warmth, the growth of the rattle evidently proceeding much more slowly in the natural state), and I do not understand why other observers have not noticed the growth of the rattle in captive Rattlesnakes. Probably the snakes were kept under conditions unfavorable for their welfare, whereby the vital processes were checked. Perhaps, too, the observations were not conducted with sufficient care.

Dr. Feoktistow's strictures upon previous observers are not quite well founded, for Dr. Holbrook has recorded, as early as 1838, that he knew two joints to have been added in one year, and that Dr. Bachman had observed four produced in the same period.* It has also been stated before that Dr. Cotton, of Tennessee, "had a Rattlesnake which shed its skin on an average twice a year, and he observed a new link to the rattle on each shedding." †

The observations made by the Russian naturalist do not in all particulars agree with those of a somewhat later investigator, whose facilities were not inferior. On the contrary, Mr. J. J. Quelch, who conducted his experiments with snakes born in confinement in the museum in

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* N. Am. Herpet., 1 ed., II, 1838, p. 85; 2 ed., III, 1842, p. 14.

† Hopley, Snakes, 1882, p. 298.

Georgetown, Demerara, consequently in a tropical climate and the home of the snakes, must be said to have had even superior advantages. In a very interesting paper published in "Timehri,"* of which he is editor, he gives as his experience that the sloughing, or exuviation, of the general skin and that of the terminal button, or cap, of the tail forming the new rattle joint take place at the same time and are part of the same process. It is consequently possible that Feoktistow's results may have been caused by irregularities of the sloughing process, due to the captivity. Out of twenty-four specimens bred in a cage in the museum, Mr. Quelch brought two up on mice till they reached a length of more than 3 feet, when the paper was written. Here is an abstract of his account relating to these specimens:

At birth they were from 9–10 inches in length and $\frac{1}{4}$ to $\frac{1}{2}$ inch thick, and like the other 22 of the set possessed but a terminal, elongated, horny, stump, though under the termination of the scales an anterior piece was to be observed. Now, 16 months after, they are more than two feet in length and more than an inch thick—one, which has throughout been the more voracious, being somewhat longer and thicker than the other—and the larger one possesses a rattle of four separable links, while the other has six of these, but the individual links considerably smaller than those of its brother. In the case of the smaller snake, with six pieces in the rattle, these correspond with each exuviation, the rattle being perfect, and bearing the terminal elongated stump with which it was born. In the other, with four, three terminal links have been lost, these having been detached during its sixth exuviation. During 16 months, therefore, the one has had seven exuviations, and the other and smaller but six.

In a later note, supplementary to the above (*op. cit.*, pp. 170–171), Mr. Quelch adds the following:

Since writing the foregoing paper it has been possible, from actual observation of these young forms, to trace the development of the rings still further. On February 5th the larger of the two young specimens was about $2\frac{1}{2}$ feet in length and possessed four rattle rings. Since then two exuviations have taken place, one on Wednesday, March 25th, when an extra ring was added to the rattle, thus making five; and again, about two months after, on May 27th, when the sixth ring was added. In the case of the smaller snake, which on February 5th was about $1\frac{3}{4}$ feet in length, two exuviations have also taken place, at intervals also of about two months between each exuviation. On February 28th an extra ring was added by change of skin; and again on May 4th, when 8 rattles were registered in total number. It is noteworthy that in the larger specimen of these two young ones there are only six rings, three having been lost in early changes, while in the smaller specimen there are eight, the total number from birth being retained, as shown by the presence of the original terminal button with which they were born. The larger specimen is now (June 11th) about $3\frac{1}{4}$ feet in length, while the smaller is about $2\frac{3}{4}$ feet. During early life these vipers are thus, with free diet, observed to exuviate and thus add to the rings of the rattles every two months.

Dr. Feoktistow, where he speaks of rattles with from 15 to 18 joints as being rare, adds in a footnote that "rattles of 42 joints, as figured by Seba, surely exist only in the imagination." There is said, however, to be a later account and figure of a rattle of no less than 44 joints,

*The Rattlesnake.—The Growth of the Rattle. Timehri (n. s.), V, pt. 1, June, 1891, pp. 1–11+plate.

viz, in the "Columbian Magazine or Monthly Miscellany" for November, 1786, as follows:

The common number of fibulæ seldom exceeds 14 or 15 in a rattle; but the one given (fig. 4) is certainly a very great curiosity, even to a person who has seen a great number of this genus of snakes. The fibulæ are 44 in number. The snake from which this rattle was taken was not, as might be expected, of a size proportionate to the prodigious length of its rattle, but rather of a middling-sized snake. It was killed some time in the summer of this year, at Fort Allen.*

The most plausible explanation seems to be that some practical joker joined several rattles, thus deceiving the unwary paragrapher.† The greatest number of joints recorded so far by a fully trustworthy authority is, I believe, 21 as seen by Holbrook (N. Am. Herpet., 1 ed., II, p. 85), unless we accept Miss Hopley's somewhat vague statement, possibly only made on hearsay, that "a Crotalus [species not given] at the London Reptilium had twenty-five links at one time" (Snakes, p. 301), or Catesby's figure of a *C. horridus* with 24 joints. (Carolina, 1743, II, pl. xli.)

If the reader will again examine the representation of a perfect and full-grown rattle, given above (fig. 23), it will be seen that the basal rings are nearly equal in size, while the terminal ones rapidly diminish in size toward the tip. The latter were, of course, formed during the early years of the snake's life, when its growth was rapid, the increasing size of each succeeding joint testifying to the corresponding increase of thickness of the end of the tail. Later on this increase is much slower and the new joints do not materially differ in diameter from the preceding one. If, therefore, in the adult snake the rattle breaks near the base, the new rattle which will grow out to succeed the lost one will have an entirely different shape, the upper and lower outlines being nearly parallel and the terminal button as large as the basal ring, while the perfect, unbroken rattle tapers off toward a small and rather elongate button. This difference between the parallelogrammic rattle and the tapering rattle was once held to indicate specific differences and was used as a systematic character, but Garman has effectually disposed of this notion in the paper on the rattle so often referred to above.

When crawling over the ground the rattle, as shown in fig. 23, is carried with the greatest width vertical and somewhat raised off the ground, so as to prevent it from dragging.

It is often sounded even in this way, but the usual position assumed by the snake when vibrating the rattle in earnest is when coiled up and

* Quoted from DeKay, Zool. N. Y., III, 1892, p. 56, footnote. Of course, we place no more credence in the story of the man who told Kalm that in his younger days he had killed a Rattler with 30 joints than in the one quoted above. (Kalm, Svenska Vetensk. Acad. Handl., XIII, 1752, p. 316.)

†A correspondent recently informed the Smithsonian Institution that he was in possession of a "fossil rattle" of about 45 joints. The fossil, when received, proved to be an *Orthoceras*, a mollusk of the Devonian age.

ready for defense or offense. The rattle is then as a rule raised nearly vertically in the middle of the coil, though it not only can, but really does, rattle with the instrument poised outside of the body rings. When shown the original drawing of the Banded Rattlesnake, now reproduced on pl. 9, a friend of mine criticised the position as unnatural, since in his opinion the snake could not sound the rattle outside of the coil. Fortunately I had a huge live Texas Rattler, *Crotalus atrox*, near by, and upon repairing to the cage and trying to induce the monster to rattle, his very first performance was given in the position shown in the criticised illustration.

The rattling sound is produced by a vigorous shaking and vibrating of the end of the tail, the dead, horny cones producing a noise of different pitch and volume dependent upon the size and vigor of the animal and the dryness of the rattle. Under ordinary circumstances the sound is not kept up constantly for any length of time, but that is not for want of ability, for it is well known that captive Rattlesnakes may be induced to rattle continuously for hours.

Dr. Feoktistow, in the memoir already quoted, has given an account of an interesting experiment made for the purpose of ascertaining the number of vibrations which the rattle makes per minute, which deserves to be reproduced here:

> A large Rattlesnake was grasped by the neck, while an assistant thrust a needle through the middle joint of its seven-jointed rattle in such a way that it pierced the rattle in its greatest diameter, consequently from above downward, if we imagine the snake lying quiet with its tail outstretched upon the ground. Now, since the rattle (in the position in which we have supposed the snake to be) is, in making a noise, moved from left to right and back again, the needle was able to trace curves of vibration upon paper blackened with soot. As a registering apparatus I used Dudgeon's polygraph, with a strip of blackened paper which was made to slide rapidly forward by means of the clockwork. The tail of the snake was, to a certain extent, fixed by my holding the snake with my hand in the region in front of the vent. After much trouble I succeeded in bringing the needle in a suitable manner into contact with the strip of paper, and in obtaining curves of vibration, from which the number of the vibrations per minute (the rapidity of the progression of the strip of paper being known) could be calculated with a fair degree of accuracy. In this manner it was found that the movements of the rattle are composed of great vibrations of the entire tail itself and of smaller vibrations of the actual rattle in such a way that the tail makes 75 and the rattle, on the other hand, 110 vibrations per minute. These are approximate average numbers, since I was able to obtain only faulty curves, because the rattle does not perform its vibrations precisely in one plane. Movements kept up for hours with rapidity like this are absolutely amazing. When observed with the naked eye, only a blurred image is seen of the rattle moving at this rate.

The Russian investigator was not the first, however, to attempt a determination of the vibrations of the Rattlesnake's tail. Dr. Isaac Ott, as early as 1882, tried an experiment similar to that of Dr. Feoktistow. From his statement* it may be sufficient to quote the following:

* The Vibration of the Rattlesnake's Tail. Journ. Nerv. and Mental Disease, New York (n. s.), VII, Jan.-Oct., 1882, pp. 514-516.

The snake experimented with was one which had been kept about nine months, and was not as energetic as one recently caught, but the note of his rattle was as usual. His head was secured by means of a wire around the neck, and at the end of his rattle was attached a short piece of thin copper wire by means of sealing wax; then the tail was taken in hand and the point of the copper pen directed against the smoked revolving drum of a Marey-Secretan apparatus. A tuning fork was run over the drum to determine the rate of movement of the drum. By an analysis of the curve it was found that the rate of vibration of the tail was about 60 per second.

Dr. Ott, it should be added, admits the possibility that the number of vibrations recorded are less than the actually normal number. Remembering the fact that the snake experimented upon was less than normally energetic, the result agrees tolerably well with that obtained by Feoktistow seven years later.

The question, "For what purpose does the snake rattle?" is still an unsolved one. Possibly it will ever remain so if we continue to look for one single purpose which may be considered so important in the animal's economy as to have brought about development of such a specialized instrument. Philosophers when attempting to explain the utility to the snake of acquiring the rattle have often failed, because it seemed evident that the rattle, so far from being useful to the snake, in most cases appears to be a disadvantage, which has led to the almost total extinction of the Rattlers in the cultivated and more densely inhabitated districts of the country. It must not be forgotten, however, that the rattle was evolved long before man appeared upon the stage, and that the question of its disadvantageousness in the struggle against his supremacy could have no influence upon its evolution. The history of evolution is full of similar examples of animals having acquired an advantageous character which, when new enemies appeared, was turned against the owner because it could not be undone or modified to suit the new conditions, thus leading directly to his extermination.

The theories of the use of the rattle are numerous, even though we exclude from the discussion the one that it is "a providential arrangement to prevent injury to innocent animals and man."

An interesting discussion of this question was started by Prof. N. S. Shaler about twenty years ago, in a paper entitled "The Rattlesnake and Natural Selection,"* in which he receded from the position previously held by him that "the tail appendage of the Rattlesnake was not to be explained on the doctrine of natural selection, inasmuch as it could contribute in no way to the advantage of the animal." Having once himself in the field mistaken the rattling for the sound made by the "locust," *Cicada rimosa*, Say, he conceived the idea that the object of the noise is to decoy insect eating birds "into the range of the serpent's spring" by an imitation of the cicada's sound, and he consequently admitted that the case of the Rattlesnake did no longer seem "the bar to the acceptance of the theory it once did."

* American Naturalist, VI, 1872, pp. 32–37.

The similarity of the rattling sound to that of certain grasshoppers has been commented on by many writers both before and since, and is indeed in many cases astonishingly deceptive; but there are several great difficulties about this theory, chief of which are that birds seem to form a very small portion of the Rattlesnake's diet, and that on the other hand the birds do not seem to rely principally on their ear in hunting grasshoppers.

Prof. F. W. Putnam (*op. cit.*, pp. 693–694) took issue with Prof. Shaler, and suggested that the true function of the rattle is most likely to serve to call the sexes together. This theory received shortly after valuable support from an observation made by Prof. Samuel Aughey, who recorded* his experience while surveying in July, 1869, along the Logan River in Wayne County, Nebraska.

> While washing a collection of unios at the water's edge [he writes] I heard the familiar rattle of the Massasauga (*Crotalophorus tergeminus* [=*Sistrurus catenatus*]). I quickly crept up the bank and cautiously looking over the level bottom I saw, at the distance of about 30 feet, a rattlesnake coiled up with the head erect and gazing in an opposite direction from my position. Every three or five minutes the snake would cease rattling for a minute or more and then commence again. In about half an hour from the time that I first saw the snake I observed another Rattlesnake approach the first one. Closer and closer the second one approached, until at length they met and indulged in a sexual embrace. I watched them for at least an hour and left them at last without disturbing them.

He also related an instance where three Rattlesnakes made their appearance on the scene of a battle between hogs and another Rattlesnake, apparently called in by the rattling of the latter.

The same observer also hints at another use of the rattle, suggesting that the noise may possibly frighten and thus paralyze the victim into submission, at the same time explaining the phenomena which by other observers have been attributed to a peculiar "charming" power supposed to be possessed by these reptiles, and of which we shall hear more further on.

The theory which appears most commonly accepted nowadays is one which was elaborated by J. G. Henderson, in a reply † to Shaler's article above referred to. He advanced the idea that the sounding of the rattle, so far from inviting the destruction of the snake,

> is one of the most effective means of self-protection, and is as useful to it in the race for life as is the growl of the tiger when threatened with danger. The snake does not sound its rattles until it considers itself discovered, and not then unless it apprehends danger. It throws itself in position to strike and says in unmistakable language, "Look out, I am ready for you!" If pushed upon, it makes its leap at its antagonist, and again throws itself in position to renew the conflict, and again sounds the note of defiance. * * * The ability of the snake to defend itself does not consist in its strength or size, or in its power of overcoming its adversary by a prolonged conflict, for most of its enemies are its superior in size and strength. Nor does its deadly poison act quickly enough to secure its own safety when it is

* American Naturalist, VII, 1873, pp. 85–86.

† Use of the Rattle of the Rattlesnake. American Naturalist, VI, 1872, pp. 260–263.

attacked, but, in most cases, the victim, after the deadly stroke is given, may still revenge itself by the destruction of the snake. But the certainty of the effect of the poison serves as a warning and is advantageous, not in defense after the attack is made, but in preventing an attack from being made.

The point here made is certainly a strong one, and the theory has been given a further application by the consideration, especially advocated by Garman,* that inasmuch as the success of the snake in capture of food depends on an ever-ready supply of poison, the rattling sound is advantageous if it keeps away disturbers which can not serve as food and thus prevents useless expenditure of venom or even the breaking of the fangs.

If we now look at the various explanations given, it seems possible to accept them all as partly true. The rattle having once been acquired it seems even probable that the snake used the sound for the various purposes indicated, though of course it may be difficult to point out which one has mostly influenced the evolution of the instrument. To me the rattling appears as a substitute for a *voice*, and I think it is quite logical to conclude that it may be put advantageously to all the uses to which an animal may apply its voice.

It has long been known that most snakes when agitated produce a whirring or rustling sound, which often strongly resembles the noise of the Rattlesnake, by rapidly vibrating the end of the tail among dead leaves, or against some other object, even their own body. Many an innocent snake has, on this account, suffered an untimely death, having been mistaken for the deadly rattler. This fact has been used as an argument in favor of the preventive theory, since, if the rattling is advantageous to the rattlesnake in preventing attack by its enemies, the imitation of the noise must also prove advantageous to the mimickers. The fact that this pseudo-rattling is indulged in by the deadly snakes without a rattle does not mitigate against this theory of imitation, for of course, if it is advantageous to the rattlesnake to have a means of preventing unneccessary waste of poison or useless exposure to breakage of the fangs, the imitation must be equally advantageous to the Copperhead or the Moccasin. But the futility of the theory is shown not only in the fact that this vibration of the tail is so universal, but still more so because it does not seem to be confined to the snakes of America, to which part of the world the Rattlesnakes are restricted.

It is evident, then, that this vibrating of the tail, so far from being an imitation of the rattlesnake's way of making itself heard, was a common characteristic of most snakes before the Rattlesnake evolved from the common ancestral stock of Pit Vipers. Whatever the cause of this phenomenon—and we may well accept Herbert Spencer's suggestion, as applied by Shaler (*op. cit.*, p. 36), that the wagging of the dog's tail and similar movements of that appendage is an escape of nervous force restrained from other modes of expression at the moment—we may take

*Ophid. N. Amer., 1883, p. xxvi; Bull. Mus. Com. Zool., XIII, 1888, p. 264.

it for granted that the forms from which the Rattlesnake evolved were in the habit of vibrating the tip of the tail at a high rate of speed. This condition clearly understood, there is no difficulty in tracing the origin of the rattle.

In this connection I may again call attention to Garman's often quoted article,* and to reproduce his figure of the tail and of a specimen of the Copperhead, *Agkistrodon contortrix* (fig. 32). It does not need long explanation to show how easily a tail cap like the one represented might be modified into the button, the ring-like swellings of which would prevent the slough from being pushed off. The development once started, the increasing irritation would lead to heightened nutrition and excessive accumulation of tissue. In tracing mentally this evolution it must not be forgotten, as Garman on a later occasion (Science, xx, 1892, p. 17) remarks, that the present development of the rattle "embraces much that is a consequence of its possession, much that has been induced by its presence and use."

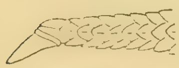

Fig 32.
TAIL END OF THE COPPERHEAD
Side view. Nearly twice natural size
(After Garman.)

Garman expressly protests against the assumption that the rattlesnakes have been derived directly from the copperhead, and thinks it more probable that the two rattlesnake genera have had a double origin, *Sistrurus* having been derived from a stock more nearly related to *Agkistrodon;* the *Crotali* proper, with small head scales, from forms nearer to *Lachesis.*

I can not agree to this proposition, which lays more stress on the number and size of the head shields than upon the rattle and the other characteristics of these snakes. The rattle is a highly specialized instrument, essentially alike both in *Crotalus* and in *Sistrurus*, while the nine large head shields, in the possession of which the latter genus agree with *Agkistrodon*, is the common, generalized arrangement which they share with nearly all the nonvenomous snakes, and which was undoubtedly a characteristic of the ancestor from which they all—including *Lachesis* and *Crotalus*—have been derived. There are, indeed, numerous examples among various species of *Crotalus* of individuals showing a tendency to a reversion to this ancestral arrangement.

The popular belief in the power of the poisonous snake to "charm" its victims into a state of helplessness is by no means exterminated. In spite of all that has been argued and explained against it there are people still who profess to have ocular proof of this power. Time and again it has been related by trustworthy observers how birds or small mammals have been seen to approach the coiled snake, drawn toward it as by a magic spell they were unable to withstand; how, under the influence of an excitement which made them forgetful to everything around them, apparently dreading the terrible fate awaiting them yet unable to avoid it, they finally ventured too near, only to be hit by the lightning stroke of the hitherto almost motionless snake, whose only

*Bull. Mus. Comp. Zool., XIII, pl. ii, fig. 14; Science, XX, 1892, p. 17, fig. 5.

sign of life consisted in the following of the victim's mad efforts with the staring eyes and the incessant darting out and in of the rapid tongue. Many of these blood-curdling tales are unfortunately embellished with such absurd details, evidently the children of an inflamed imagination, as to throw discredit on the whole story. It is not uncommon to hear it stated that the eyes of the snake were emitting fire, and that the unfortunate victim finally darted directly into the widely expanded mouth of the expectant reptile.

In spite of these extravaganzas, however, there is evidently enough truth in the numberless observations of this nature to keep the scientists (whose duty it is to doubt and dissect all these things) busy trying to evolve a theory by which to explain so much of the stories as appeared worthy of being admitted as facts. Old as the stories are, the explanations and theories of the doubters are not of yesterday either. One hundred and forty years ago Peter Kalm, a Swedish naturalist, and pupil of Linnæus, wrote a detailed and, considering the time, accurate and interesting account* of the Rattlesnake, based upon his experience during his travels in Eastern North America, in which he gives an elaborate description of how the fascination is said to take place. He then continues as follows:

This is the story as commonly told by the inhabitants of North America, both by the common people and by the better classes, by the ignorant as well as by the learned. I myself have never seen it, and have even now great difficulty in believing it. Among the many hundreds who have told me of it not more than ten or twelve asserted that they had seen it with their own eyes. However, among these there were some men so trustworthy, and their accounts agreed in most particulars so well, that I almost gave up all doubt as to the truth.

I have attempted to explain this alleged charm in this way: I have seen in America how numerous birds in the woods were running on the ground in search of food and so tame that a man could approach very close; they might in the same manner get too near to the snake, which is lying quiet and thus might easily have a chance to strike them; the bird is unable to get away farther than the nearest tree, where it is obliged to rest and finally falls down, the snake now seizing its prey. This explanation was particularly suggested to me by the story told me by a woman in America, who had once seen a rabbit running across the road, then suddenly stop and fall down as if crazy. She then saw a Rattlesnake which had followed the rabbit, but she did not take time to observe what followed. We often see that when a cat is out hunting, the little birds collect about him from some distance, uttering a certain cry. If the bird has its nest in the neighborhood, the greater noise it will make and the nearer it will approach. The cat walks quietly along, as if it does not concern him at all; the bird becomes the more daring; it approaches nearer and nearer till it comes within reach of the cat, or even darts down upon his back; that is the opportunity of the cat to grab it. Some small birds in America, not at all afraid or having their nest near the roadside, often act in the same manner at the approach of man, often flying almost direct in the faces of the passers-by. As the sparrows pursue the hawk, thus small birds make outcries at their enemies and become more daring the quieter the latter are; the same, possibly, takes place with the fascination of the rattlesnake. Or may it be that they approach too close out of curiosity, since his eyes glitter and burn like fire when angry or when said to be fascinating? Or is it

* Sv. Vetensk. Acad. Handl., XIII, 1752, pp. 308–319; XIV, pp. 52–67; pp. 185–194.

possible that the charm is due to some fetid and poisonous odor which he emits and by which the animals are overcome and made unconscious? Or may not every one of these suggestions contribute toward the result?

The speculations of a century and a half have added scarcely any new suggestion of apparent plausibility to those of Dr. Kalm, except, perhaps, the idea that the whirring noise of the rattle might produce such a terror in the intended victims as to completely paralyze their will power.

On the other hand, there has accumulated a mass of negative evidence in the shape of observations on snakes in captivity, which have led some authorities to deny entirely the actuality of the phenomenon. Dr. S. Weir Mitchell, who has had unexcelled opportunities of observation, has this to say* upon the subject:

I have very often put animals, such as birds, pigeons, guinea pigs, mice, and dogs, into the cage with a Rattlesnake. They commonly exhibited no terror after their recovery from alarm at being handled and dropped into a box. The smaller birds were usually some time in becoming composed, and fluttered about in the large cage until they were fatigued, when they soon became amusingly familiar with the snakes, and were seldom molested, even when caged with six or eight large *Crotali*. The mice, which were similarly situated, lived on terms of easy intimacy with the snakes, sitting on their heads, moving round on their gliding coils, undisturbed and unconscious of danger. Larger animals were not so safe, especially if they moved abruptly and rapidly about the snakes. The birds, mice, and larger animals often manifested an evident curiosity, which prompted them to approach the snake cautiously. Sometimes this was rewarded by a blow, as was sure to be the case when a dog indulged his inquisitiveness by smelling the snake with his muzzle. Sometimes the snake retreated, and struck only when driven to bay. Usually, the smaller animals indulged their inquisitive instinct unhurt, and were allowed to live for days in the same cage with the dreaded reptile.†

These are the sole facts which I have seen bearing any relation to the supposed fascinating faculty. They appear to me to lend no strength to the idea of its existence.

Similar evidence is given by numerous other observers, some expressly adding that even the most threatening rattling did not seem to have any terrorizing effect upon the captive animals.

It should not be forgotten, however, that Rattlesnakes in captivity, as a rule, are very timid, dull, and with but very little desire to eat. Their victims, moreover, if wanted, are within easy reach, consequently there would be no necessity for exerting any faculty of fascination, even if the snake possessed it.

Dr. Alfred Brehm's experience, on the other hand, is more positive and seems directly to corroborate Kalm's first suggestion. According to Prof. F. L. Oswald's version, Brehm procured a couple of able-bodied Rattlesnakes and turned them loose in a well-lighted garret, where he could observe all their movements without betraying his presence. At first

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*Researches on the Venom of the Rattlesnake, 1861, p. 5.

† It is proper to add that the curiosity thus exhibited by animals, and especially by mice and dogs, was as active when the snake was not regarding the intruder as at other times.

his prisoners stayed in their lair in the recess of an open box, but on the morning of the third day they began to show symptoms of appetite, and the professor treated them to a breakfast of live blackbirds. About five minutes after the appearance of the newcomers, one of the snakes left her headquarters and crawled across to the corner next to the front window, while her mate took post behind a waterpot near the center of the room. The birds were too busy to notice them at all. The temptation to attempt escape in a lightward direction seemed to occupy them too much to mind such inferior incidents as the maneuvers of a crawling object on the floor. The front window with its large panes seemed to prove specially attractive, and the ambushed snake had just contracted her coils for the third time when the descent of a fluttering bird gave her a chance to bring matters to a crisis.

"No need of charming in this case," thought the professor when the stricken blackbird recoiled with a frightened squawk. But there was still need of patience. For nearly a minute the doomed bird fluttered about in an aimless way before the chemicals began to operate in earnest and he fell over on his side with half-opened wings. He was too far gone even to keep on his legs, and only then the snake crawled up to take possession of her prey, though she had all along watched her victim with glittering eyes.

Brehm repeated his experiment with sparrows, gophers, common rats, weasels, quails, woodpeckers, and meadow larks, and always with an analogous result, except in the case of a woodpecker that made its way to the top of the window and died out of reach of the serpent. In every other case the victim at first made its escape, but was captured *in articulo mortis*, after betraying its waning strength by all sorts of curious symptoms. Even the weasel gave up its attempt at retaliation after a short struggle, and in its last moments staggered out of its hiding-place and finally directly toward the approaching enemy.

I think I have seen it suggested somewhere, though I am now unable to find the reference, that the alleged faculty of fascination might be of a hypnotic nature. This suggestion may not be so entirely absurd as at first appears, if we remember the highly nervous and excitable nature of the birds and the ease with which some of them, at least, are brought under influences similar to those of hypnotism. In this connection I may call attention to a very curious device used in some parts of Germany for decoying larks, the so-called "lark mirror" (*Lerchenspiegel*). As described and figured by Naumann* it consists of an oval piece of wood studded with small pieces of broken looking-glass, some not larger than a pea, which is made to revolve upon a low stick put into the ground. The glittering of the revolving glass pieces reflecting the sun seems to attract the larks, which dart down upon it and are then caught in the nets. The flickering light seems to "fascinate" the bird.

*Naturgeschichte der Vögel Deutschlands, IV, pp. 186–187 (1824).

After all, is not the objection which some authors make to the power of "charming" or "fascinating" more directed against the use of these words themselves than against the phenomenon which they are intended to describe?

The possibility, already expressed by Kalm, that the victims might be overcome by a special fetid smell, said to be emitted by the snake, does not seem to have any foundation in fact, much less the more fanciful suggestion by more "popular" writers that the cause is a poisonous quality of the snake's breath. It is true that there are situated some glands about the vent which eject a fluid of a penetrating odor, if the snakes are handled roughly, but it is a common observation that the crotalids under ordinary circumstances issue no peculiar odor. Dr. Mitchell states that the fluid referred to is of a yellow or dark brown color; that it may be ejected to a distance of 2 or 3 feet, and that it is irritant when it enters the eye, although not otherwise injurious. I am not aware that these glands and their secretion in the pit vipers have been studied in detail.

Occasionally we hear of the finding of large numbers of Rattlesnakes or copperheads in caves in rocks brought to light by blasting for a railroad or a quarry. We are also all familiar with the periodically recurring story, now at least 200 years old, however, of the man who built his log cabin against the side of the mountain in such a manner that the perpendicular face of the rock formed the back wall of the hut, and who with his family had to spend the first night among the rafters because the heat from the fire had thawed out the inhabitants of a vast rattlesnake "den" somewhere in the rock, the noisy serpents coming out by the hundreds and taking possession of the floor and the beds. We have also heard the more modern and improved edition of this story, apparently due to the vivid imagination of western journalists, according to which the Kansas farmer erected the same log cabin in the same position—not for himself, however, but for his son, who intended to spend his honeymoon in it, and who, with his young bride, was found the morning after the wedding, killed and partly eaten by an army of the loathsome reptiles. It would fill an entire volume were I to mention all the gruesome snake stories that are served up by an enterprising press with an ever increasing amount of high seasoning to satisfy the cravings of a public now habitually fed on sensations. Stripped of all the lurid word painting, of all the epithets suggesting slimineess and other qualities not belonging to any snakes, and of all exaggerations as to numbers, stench, and noise, there lies at the bottom the truth that these poisonous snakes, like many others of the harmless kind, in winter often congregate in great numbers in some cavity in the ground or among rocks. In these retreats they spend the cold season in a state of more or less deep stupor, or lethargy, until warm weather comes to quicken their pulses, when they issue from their winter

quarters, spreading out over the neighboring region and passing the summer solitary or in pairs. In very hot and dry climates this hibernation has an equivalent in the æstivation, by which term Dr. Cooper has designated a similarly lethargic state during the hottest and driest portion of the summer.

Considering the small number of these snakes met with in the fields or in the woods during the warm seasons, the large numbers sometimes found in these Rattlesnake dens in winter is simply astounding. It seems as if all the pit vipers of the surrounding country had come together in one spot, and there are good reasons to suppose that so is actually the fact. The question naturally arises: How have all these snakes obtained their information about this apparent place of rendezvous and how have they been able to find their way to it? It is a phenomenon in its nature not unlike that of the migration of birds, and is apparently even more difficult of a satisfactory explanation. The old pre-darwinian conception of the inherent and infallible instinct explains neither, but how is the more scientific idea of the inherited, unconscious knowledge accumulated and crystallized, as it were, during countless generations, how is it to apply in the present case?

As a matter of fact we know yet too little of the habits of the snakes and of their whole life history to give any explanation much better than a conjecture. I shall, therefore, not attempt any solution of the question here, but for the benefit of those who might want to take it up I shall quote an ingenious theory propounded recently by Mr. W. H. Hudson,* whose charming pictures of animal life in the Argentine Republic has made his name a household word among naturalists. After having briefly alluded to the habit of the rattlesnake to hibernate socially in dens, he proceeds as follows:

> Clearly in this case the knowledge of the hibernating den is not merely traditional—that is, handed down from generation to generation, through the young each year following the adults, and so forming the habit of repairing at certain seasons to a certain place—for the young serpent soon abandons its parent to lead an independent life; and on the approach of cold weather the hibernating den may be a long distance away, 10 or 20, or even 30 miles from the spot in which it was born. The annual return to the hibernating den is then a fixed unalterable instinct, like the autumnal migration of some birds to a warmer latitude. It is doubtless favorable to the serpents to hibernate in large numbers massed together, and the habit of resorting annually to the same spot once formed, we can imagine that the individuals—perhaps a single couple in the first place—frequenting some very deep, dry, and well-sheltered cavern, safe from enemies, would have a great advantage over others of their race; that they would be stronger and increase more, and spread during the summer months farther and farther from the cavern on all sides, and that the farther afield they went the more would the instinct be perfected, since all the young serpents that did not have the instinct of returning unerringly to the ancestral refuge, and that, like the outsiders of their race, to put it that way, merely crept into the first hole they found on the approach of the cold season, would be more liable to destruction.

*The Naturalist in La Plata (London, 1892), pp. 321-322.

Of all our native snakes, the habits of none are better known than those of our pit vipers, yet there are many points in dispute which it will require time and patience and good luck to settle. Other questions which we have considered to be answered must be discussed over again, because later observations seem to cast doubt upon the conclusions long since arrived at. Thus, we have believed it an undoubted fact that all the Pit Vipers bring forth their young alive. Gradually the conclusion had been gained that all of them in this respect are essentially alike, and that the progeny is comparatively limited in number. The constantly repeated stories of Copperheads having had innumerable young ones have been shown to rest on confusion with the young of the spreading adder. The average number of young Pit Vipers born by species occurring in our country seems to be 8 or 9, exceptionally as high as 14, while as many as 24 have been authentically recorded for some exotic forms. But now we read in the very latest edition of Brehm's "Thierleben" (Vol. VII, 1892, p. 444) that credence is given to the account of Geyer that he has observed a nest of about 40 Rattlesnake eggs in the very act of hatching! Now it is quite true that there are reptiles in which the time of the hatching and that of the expulsion of the eggs are so close that sometimes the young ones are hatched within the body of the mother, and thus born alive, but with these snakes the case is somewhat different, for the egg covering is so thin that it is most improbable that the eggs are ever expelled before the young have broken through.

In close connection with the above we are confronted by a not unfamiliar question: "Do the snakes swallow their young for the sake of protection?" Concerning, as it does, the snakes in general and not the pit vipers in special, except in so far as they are reported to be among the ones observed to do this very thing, I should have left this theme at the present occasion with a reference to Dr. G. Brown Goode's admirable summary of all the evidence up to 1873,* as it would carry us too far to present all that has been written about the subject since then in this connection, but from the many unpublished letters in my possession bearing upon the question, and which I have reserved for a later separate publication, I wish to print the following extracts from one by the late Dr. William C. Avery, of Greensboro, Ala., because they pointedly expose the inconsistency of some of those who deny the actuality of an occurrence testified to by numerous and competent witnesses, simply because it seems improbable and because they have not seen it themselves. Apropos of an account in a previous letter of how he himself once saw a young water moccasin run down its mother's throat, Dr. Avery wrote as follows:

My reason for mentioning in my last letter the fact that I had seen a snake take her young into her throat was that it had been denied by some writers. In a work

*On the question "Do Snakes Swallow their Young?" Proc. Amer. Assoc. Advanc. Science, Portland Meeting, 1873 (pp. 176–185).

by Charles C. Abbott, M. D., entitled "Model Book of Natural History," the writer says, on page 499: "The threadbare subject of snakes swallowing their young has been discussed again and again. The sum and substance of the matter is—they don't." * * * The fact of the matter is—*they do;* and men believe they do, because they have seen the young in the act. Dr. Abbott denies this truth, and yet on page 72 of his "Model Book," he writes: "Honey badgers are said to sit on their haunches and shade their eyes with one paw while on the lookout for a bee tree. This may seem a fishy story, but there is no reason for not accepting it. The world is more full of marvels than mankind have imagined."

Surely, the alleged performance of the snakes is not any more marvelous than that of the honey badger!

It was noted under the Harlequins, or Bead Snakes, that those poisonous snakes are closely imitated by certain kinds of harmless ones, so close, in fact, that it is sometimes necessary to discriminate very nicely in order to distinguish them. Some of the crotalids are subjects of a similar mimicry which has given rise to a similar confusion of names. Thus the ordinary and very harmless hog-nose snake, or spreading adder, is in many districts known as the copperhead, on account of its superficial resemblance to the latter and the dread inspired by its certainly formidable looking antics is still heightened

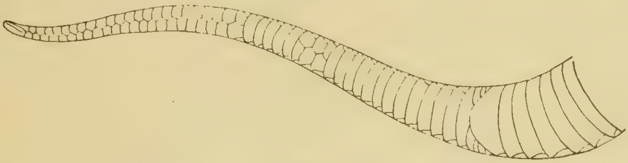

Fig. 33.
UNDER SIDE OF TAIL OF WATER MOCCASIN.

by the terror which tradition attaches to the name. The case of the water moccasin is similar. The name Moccasin has nearly lost its significance and needs a qualifying adjective in order to convey with certainty the meaning of the employer whether he intends the poisonous or the harmless kind. Dr. G. Brown Goode has called attention * to the close imitation of *Agkistrodon piscivorus* (the Moccasin) by the Banded Water-snake, *Natrix fasciatus*, and asks justly, "Is not this a fair case of protective mimicry?"

There should never be any difficulty in distinguishing these imitators from the poisonous species they mimic, with the specimens in hand, for the absence or the presence of the "pit" would at once settle the question. Very often the slayer of the serpent deems it a religious duty to immediately put his heel to its head and crush it out of all recognition. In such cases the tail may serve as a distinguishing character, for in the hog-nose snake, *Heterodon*, and in the water snake, *Natrix*, the large scales covering its under side are divided on the middle line, while in the venomous Copperhead and Water Moccasin the greater majority of these subcaudals are undivided. The accompanying figures (figs. 33, 34) show this distinction, and the heads of the harmless

* Mimicry in Snakes. Amer. Naturalist, VII, Dec. 1873, pp. 747–748.

imitators (figs. 37, 38, 39, 40) may also serve to aid in the identification when compared with figures 35 and 36 and with those of the various venomous species given farther on under the heads of the latter.

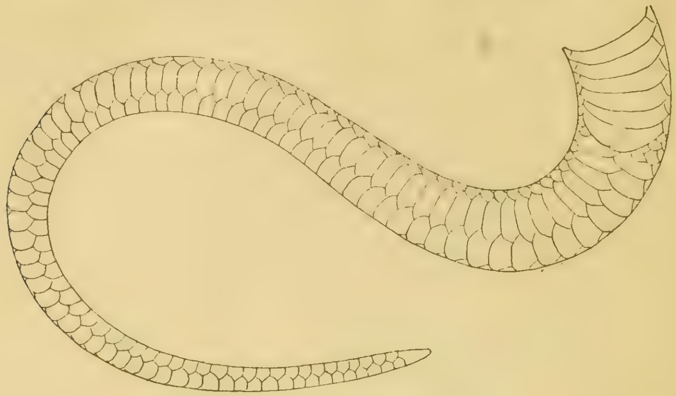

Fig. 34.
UNDER SIDE OF TAIL OF WATER SNAKE, NATRIX.

With living snakes the matter is more difficult. To the person familiar with the various kinds of snakes, their appearance and their habits, there may be no special difficulty in quickly recognizing them, if he gets a good view of them, but it would be useless to attempt by

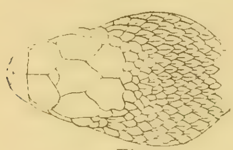

Fig. 35.

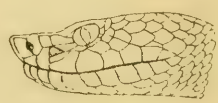

Fig. 36

HEAD OF COPPERHEAD, SHOWN FROM TOP AND SIDE.
(After Baird.)

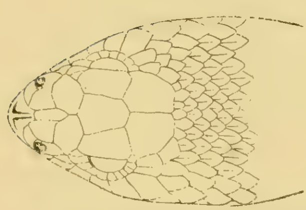

Fig. 37.

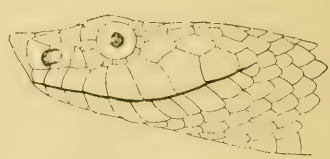

Fig. 38.

HEAD OF SPREADING ADDER (HETERODON), SHOWN FROM TOP AND SIDE.

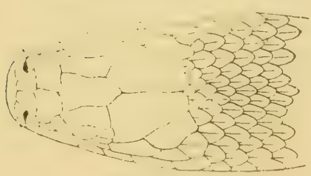

Fig. 39.

Fig. 40.

HEAD OF WATER SNAKE (NATRIX), SHOWN FROM TOP AND SIDE.

description, or even by figure, to make the differences of the living snakes so plain to those who have not learned to discriminate between them, with the specimens in hand, that it would be of any value to him.

COPPERHEAD,—AGKISTRODON CONTORTRIX.
From a cast in the U. S. National Museum.

Synopsis of the Crotalid genera inhabiting North America north of Mexico.

a^1 Tail without rattle, ending in a point........................... AGKISTRODON.
a^2 Tail provided with a rattle.
  b^1 Top of head covered by regular shields .... SISTRURUS.
  b^2 Top of head covered by numerous scales.......................... CROTALUS.

Genus AGKISTRODON,* Beauvois.

THE MOCCASINS.

1799.—*Agkistrodon*, BEAUVOIS, Trans. Am. Philos. Soc., IV, p. 381 (Type *A. mokasen* Beauv.).
1802.—*Scytale*, LATREILLE, Hist. Nat. Rept., III, p. 158 (same type).
1803.—*Cenchris*, DAUDIN, Hist. Nat. Rept., V (p. 358) (same type; not of Beauv., 1799).
1819.—*Scytalus*, RAFINESQUE, Sillim. Journ., I, p. 84 (emend.).
1826.—*Tisiphone*, FITZINGER, N. Class. Rept., pp. 34, 63 (type *T. cuprea* Fitz.).
1836.—*Acontias*, TROOST, Ann. Lyc. Nat. Hist. N. Y., III, p. 176 (type *A. leucostoma*).
1836.—*Toxicophis*, TROOST, Ann. Lyc. Nat. Hist. N. Y., III, p. 190 (same type).
1854.—*Ancistrodon*, BAIRD, Serp. N. Y., p. 13 (emend.).

Synopsis of the species of Agkistrodon occurring in the United States.

a^1. A loreal; orbit separated from supralabials by scales; usually 23 scale-rows. *A. contortrix.*
a^2. No loreal; supralabials entering orbit; 25 scale-rows .... *A. piscivorus.*

THE COPPERHEAD.

Agkistrodon contortrix,† (Linnæus.).

Plate 3.

1766.—*Boa contortrix* LINNÆUS, Syst. Nat., 12 ed., I, p. 373.—*Scytale contortrix*, LATREILLE, Hist. Nat. Rept., III, p. 159 (1802).—*Cenchris contortrix*, GRAY, Ann. Philos., 1825, p.—. — GRAY, Cat. Snakes Br. Mus., p. 16 (1849).—GRAY, Zool. Miscell., p. 50 (1842).—*Trigonocephalus contortrix*, HOLBROOK, N. Am. Herpet, 1 ed., II, p. 69 (1838).—HOLBROOK, N. Am. Herpet, 2 ed., III, p. 39 (1842).—KIRTLAND, in Mather's Sec. Rep. Geol. Surv., Ohio, 1838, p. 167.—DE KAY, Zool. N. Y., III, p. 53 (1842).—LE CONTE, South. Med. Surg. Journ., IX, 1853, pp. 651, 665.—DUMÉRIL et BIBRON, Erpét. Génér., VII, ii, p. 1494 (1854).—HALLOWELL, in Sitgreave's Exp. Zuñi Colo. Riv., p. 147 (1854).—HALLOWELL, Proc. Phila. Acad., 1856 (p. 249).—JAN, Rev., Mag. Zool., 1859, Extr. p. 29.—JAN, Elenc. Sist. Ofid., p. 125 (1863).—*Agkistrodon contortrix*, BAIRD and GIRARD, N. Am. Serp., p. 17 (1853).—JORDAN, Man. Vertebr. North. U. S., 5 ed., p. 199 (1888).—HAY, Proc. U. S. Nat. Mus., XV, 1892, p. 386.—HAY, Batr. Rept. Indiana, p. 123 (1893).—HURTER, Trans. St. Louis Acad. Sc. VI, p. 258 (1893).—H. GARMAN, Bull. Essex Inst., XXVI, 1894, p. 36.—*Ancistrodon contortrix*, BAIRD, Serp. N. Y., p. 13 (1854).—BAIRD, Mex. Bound. Surv., II, Rept., p. 15 (1859).—COPE, Proc. Phila. Acad., 1859, p. 336.—COPE, Bull. U. S. Nat. Mus., No. 1, p. 31 (1875).—COPE, Bull. U. S. Nat. Mus., No. 17, p. 24 (1880).—COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 683 (1892).—ALLEN, Proc. Boston Soc. Nat. Hist., XII, 1868, pp. 11, 35.—COUES, Proc. Phila. Acad., 1871, p. 48.—CRAGIN, Trans. Kansas Acad.

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*From the Greek ἀγκιστρον (agkistron), a hook; ὀδών (odon), a tooth.
† From the Latin *contortrix*, one who twists.

Sc., VII, p. 121 (1881).—SMITH, Rep. Geol. Surv. Ohio, IV, 1882, p. 675.—TRUE, in Hammond's South Carolina, p. 235 (1883).—KUNZE, Amer. Natural., XVII, 1883, p. 1229.—YARROW, Bull. U. S. Nat. Mus., No. 24, pp. 12, 80 (1883).—GARMAN, Rept. Batr. N. Am., I, Ophid., pp. 120, 178 (1883).—DAVIS and RICE, Bull. Ill. State Lab. Nat. Hist., I, No. 5 (p. 28) (1883).—DAVIS and RICE, Bull. Chic. Acad. Sc., I, p. 28 (1883).—HAY, Amph. Rept. Indiana, p. 13 (1885).—H. GARMAN, Bull. Ill. State Lab. Nat. Hist., III, p. 314 (1892).

1799.—*Agkistrodon mokasen*, BEAUVOIS, Trans. Am. Philos. Soc., IV, p. 370, footnote.

1803.—*Cenchris mokeson*, DAUDIN, Hist. Nat. Rept., V, p. 358.

1819.—*Scytalus cupreus*, RAFINESQUE, Sillim. Journ., I, p. 84.—HARLAN, Med. Phys. Res. (p. 130) (1835).

1819.—*Scytale mockeson*, SAY, Sillim. Journ., I, p. 257.—*Cenchris mockeson* HARLAN, Journ. Phila. Acad., V, 1827 (p. 366).—HARLAN, Med. Phys. Res. (p. 128) (1835).

1827.—*Cenchris marmorata*, BOIE, Isis, 1827, p. 562.

1836.—*Acontias atrofuscus*, TROOST, Ann. N. Y. Lyc. Nat. Hist., III, p. 180.—*Toxicophis atrofuscus*, BAIRD and GIRARD, N. Am. Serp., p. 150 (1853).—*Trigonocephalus atrofuscus*, HOLBROOK, N. Am. Herpet., III, p. 43 (1842).—DE KAY, Zool. N. Y., III, p. 55 (1842).—*Cenchris atrofuscus*, GRAY, Cat. Snakes Brit. Mus., p. 16 (1849).—*Ancistrodon atrofuscus*, COPE, Bull. U. S. Nat Mus., No. 1, p. 34 (1875).

1837.—*Trigonocephalus cenchris*, SCHLEGEL, Essay Physiogn. Serp., I, p. 191; II, p. 553.—MAX V. WIED, Verz. Rept. Reise N. Amer., p. 77 (1865).

1853.—*Trigonocephalus histrionicus*, DUMÉRIL, Mém. Acad. Sc. Paris, XXVIII (p. 534); Prodr. Class. Serp., p. 138.

1883.—*Ancistrodon contortrix*, var. *atrofuscus*, GARMAN, Rept. Batr. N. Am., I, Ophid., p. 178.

Figures.—DAUDIN, Hist. Nat. Rept., V (pl. LXX, figs. 3, 4), (1803).—HOLBROOK, N. Am. Herpet., 1 ed., II, pl. XIV (1838); 2 ed., III, pl. VIII; pl. IX (*atrofuscus*) (1842).—DE KAY, Zool. N. Y., III, pl. IX, fig. 18 (1842).—BAIRD, Serp. N. Y., pl. I, fig. 3 (1854).—BAIRD, Pac. R. R. Rep., X, Rept., pl. XXV, fig. 12 (1859).—JAN, Icon. Ophid., livr. 46, pl. V, fig 1 (1874).—BOCOURT, Miss. Scient. Mexique, Zool. III, Rept., pl. XXVIII (1882).—GARMAN, Rept. Batr. N. Am., I, Ophid., pl. VIII, fig. 1 (1883).—Brehm's Thierleben, 3 ed., VII, p. 468 (1892).

It does not appear that any competent herpetologist has ever examined a specimen of the so-called "Highland Moccasin," described by Troost as *Acontias atrofuscus*, and said to occur in the mountain regions from Virginia southward, and its status is therefore so doubtful that I have not ventured to treat it as a separate form. Even Holbrook, who gave a figure and a lengthy description, did not see a specimen, and furnished it only on Troost's authority. On the whole, this variety appears to be only a partial melanism, as we frequently find it among snakes in similar localities.

*Description.**—Loral present. Labials not entering into the orbit. Dorsal rows of scales, 23. Color, light chestnut, with inverted Y-shaped darker blotches on the sides. Labials yellowish white (figs. 41 and 42).

More slender than *Toxicophis* [*Agkistrodon*] *piscivorus*. Plates on neck and side smaller. Two anterior orbitals, one above the other, the lower narrower and forming the posterior wall of pit. A distinct loral

* By S. F. Baird, in Baird and Girard's N. Am. Serp., p. 17.

between these and the posterior nasal. Labial not forming part of the orbit, but separated by the four post and suborbitals. Labials not so largely developed; 8 above, third and fourth largest; 9 below.

Above light hazel brown, rather brighter on the top of the head, and everywhere minutely mottled with very fine, dark points. On each side is a series of 15 to 26 darker chestnut-colored blotches resting on the abdominal scutellæ [ventrals. or gastroteges], and suddenly contracting about the middle of the side, so as somewhat to resemble an inverted Y. These blotches extend to the vertebral line, where they may be truncated or end in a rounded apex. Generally, those of opposite sides alternate with each other, but frequently they are confluent above, forming continuous bands. They are so disposed that the intervals between the successive blotches are pretty much of the same shape and size, though inverted. The centers of the blotches are lighter; in some cases

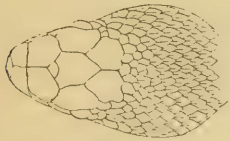

Fig. 41.

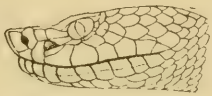

Fig. 42.

HEAD OF COPPERHEAD, SHOWN FROM TOP AND SIDE.

(After Baird.)

so much so as greatly to increase the Y-shaped resemblance. Color beneath dull yellowish, with a series of distinct large, dark blotches, 35 to 45 in number, on each side. Chin and throat unspotted. Sides of head cream color the line of demarcation very distinct; this passes along the upper edge of head, in front of the eye, and involving the lower three-fourths of the orbit, intersects the middle of the second postorbital plate (counting from above), and extends along the first row above the labials to the posterior edge of the last labial. The line then comes back through the middle of the lower labial range, where it is marked by a narrow black line. Rostral of the same color. A small areolated dark spot near the inner edge of each occipital [parietal] plate.

Number of gastrosteges, 150 to 154; urosteges, undivided, 31 to 48; divided, 0 to 18 pairs.

Fresh colors of Agkistrodon contortrix (young)—No. 19261; District of Columbia, Government Insane Asylum grounds; Dr. J. W. Blackburn, collector, September 16, 1892 (died in captivity October 31, 1892). Ground color above dull vinaceous-cinnamon (Rob. Ridgway, Nomenclator of Colors, pl. IV, fig. 15), head darker, drab (III, 18), marked with tawny on the temples; dark markings, dark Prout's brown (III, 10), gradually fading into drab on the sides; tip of tail for the extent of about 20 mm., both above and below, bright olive-yellow (VI, 16), the general ground color gradually fading into it at about 25 mm. from the tip; ground color below ecru-drab (III, 21), dark markings seal-brown (III, 1); lips pale ecru-drab, the dark edge externally shaded with tawny-olive. Iris silvery vinaceous-cinnamon.

Variation.—There is considerable individual variation in the size of the parietal plates, and the number of supralabials varies between 7 and 8, as shown by Prof. Cope. The regular number of scale rows across the middle of the body is 23, but occasionally a specimen may be found with 25.

We have already referred to the probably melanistic variation of specimens from Tennessee which have been described as *A. atrofuscus*. The number of dark cross-bands is also very variable, as shown in the description given above. Mr. Ragsdale has, in letters to me, alluded to the fact that the specimens taken by him in Texas had the tip of the tail greenish, while in eastern specimens it is stated to be blackish. The material at hand, faded through long immersion in alcohol, throws but little light upon the question, but in freshly killed specimens from the neighborhood of Washington, I find that in the adult specimens the tip of the tail above is of the same dark brownish color as the dorsal blotches; in the young specimens, however, it is bright greenish yellow, and it seems quite probable that in half-grown specimens it may be of an intermediate olivaceous color.

Geographical distribution.—In a general way the range of the Copperhead is coextensive with that of the Banded Rattlesnake, *Crotalus horridus*, though as a rule it does not extend quite as far North. As a compensation it goes considerably further South in the western portion of its range, extending into the southern part of Texas.

In the Northeast it does not seem to reach further North than central Massachusetts, though De Kay states that Holbrook had received specimens from Vermont. Dr. J. A. Allen (Proc. Boston Soc. Nat. Hist., XII, 1868, p. 11) speaks of its occurrence in Massachusetts as follows:

> There is a well-known den of this species on Mount Tom, near which a considerable number of specimens are annually killed by different individuals. I have not heard of it elsewhere in the State [Massachusetts], though Linsley has reported it from Connecticut.

It is repeatedly asserted that the Copperhead does not occur in Florida; but while it does not appear to be found in the peninsula proper, it has been taken at its very base, as testified by specimens from Gainesville sent to the National Museum by Judge J. Bell.

In Michigan, Wisconsin, and Nebraska it is lacking, and apparently also in Iowa, as I find no reliable record of its capture in that State.

In Indiana, writes Dr. Hay, this venomous serpent, once abundant in most localities of the southern half of the State, is now happily becoming rare; in most localities it is probably entirely exterminated. Where, however, the country is not thickly settled, and where there are abundant forests and rocks, it may even yet be found in considerable numbers. In the northern portion of the State it has probably always been scarce, but still present. The record for Illinois as given by H. Garman is similar: "Throughout the State; rare north, frequent south."

West of the Mississippi it has been recorded from Missouri and

Kansas, Indian Territory, Louisiana, all the way down to the pine woods north of Lake Pontchartrain, where Dr. G. Kohn informs me that it is scarce, however. In Texas it seems well represented east of the one hundredth meridian and north of the twenty-ninth parallel.

Habits.—It is agreed by almost all observers that the Copperhead, or Upland Moccasin, Chunk-head, Deaf Adder, or Pilot Snake, as it is called in various localities, is a much more vicious animal than the Rattlesnake; not only because it strikes without giving the warning of the rattle, though it is sometimes known to attempt this by quickly vibrating the tail against some hard and dry objects, but also because it is of a much more aggressive nature. However, although considerably quicker of motion than the Rattler, it is a comparatively slow snake, and as Dr. Weir Mitchell has shown that its poison in proportion to the quantity is less virulent than that of the Rattlesnake, its bite is less dangerous, and as it but seldom exceeds 3 feet in length,* it is a much less terrible animal than generally supposed.

Dr. H. C. Yarrow has reported quite an interesting series of cases of poisoning from bites of copperheads (Am. Journ. Med. Sc. (n. s.), LXXXVII, 1884, pp. 422–435). Of the many cases recorded in the medical journals he had only found one fatal case, viz, that of a 6-year-old boy, although some of them were very severe, particularly the one which came under his own observation, a case the more remarkable as the snake was very small, "not over 14 inches long." It is plain from the symptoms, however, that the case owed but very little of its severity to the venom injected by the snake, and it is an excellent example of how complicated such cases may be, and how difficult it is in cases both of recovery and death to say how much is due to the activity of the venom and how much to other circumstances.

Dr. R. E. Kunze (Am. Natural., XVII, 1883, pp. 1229–1238) thinks that the Copperhead does not strike from a regular coil, like the Rattlesnake, but that its effective blow is delivered when the middle of the body is thrown into long, almost rectangular curves, and the head held only slightly elevated above the ground.

S. Garman, as quoted by Dr. Hay, having studied the Copperhead in captivity, states that they usually eat the prey as soon as it is dead and even before it ceases to struggle. Sometimes lively mice would elude two or three strokes, and this would seem to throw the snake into an ecstacy of excitement. They would not eat fishes.

The Copperhead produces living young like the other crotalids, the average number apparently varying between seven and nine. Statements often seen in newspapers referring to female copperheads with an enormous number of young ones having been killed are due to a confusion of this species with other snakes.

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*A large male killed this year near Washington, D. C., and presented by Dr. J. W. Blackburn to the Museum, measured, when fresh, 38 inches (about 965 mm.), while a female killed near the same place last year was only about 1 inch shorter.

THE WATER MOCCASIN.

Agkistrodon piscivorus * (Lacépède).

Plate 4.

1789.—*Crotalus piscivorus*, LACÉPÈDE, Hist. Nat. Serp., II, Table Méth., p. 130.—*Scytale piscivora*, LATREILLE, Hist. Nat. Rept., III, p. 163 (1802).—*Scytale piscivorus*, DAUDIN, Hist. Nat. Rept., V, p. 344 (1803).—*Natrix piscivorus*, MERREM, Tentamen, p. 131 (1820).—*Trigonocephalus piscivorus*, HOLBROOK, N. Am. Herpet., 1 ed., II, p. 63 (1838).—HOLBROOK, N. Am. Herpet., 2 ed., III, p. 33 (1842).—DE KAY, Zool. N. Y., III, p. 55 (1842).—LE CONTE, South. Med. Surg. Journ., IX, 1853, pp. 651, 664.—DUMÉRIL et BIBRON, Erpét. Génér., VII, ii, p. 1491 (1854).—JAN, Rev. Mag. Zool., 1859, extr. p. 29.—JAN, Elenc. Sist. Ofid., p. 125 (1863).—*Cenchris piscivorus*, GRAY, Zool. Misc., p. 51 (1841).—GRAY, Cat. Snakes Brit. Mus., p. 16 (1849).—EFFELDT, Zool. Garten, XV, 1874 (p. 1).—*Toxicophis piscivorus*, BAIRD and GIRARD, N. Am. Serp., p. 19 (1853).—BAIRD, Pac. R. R. Rep., X, Whipple's Route, Rept., p. 40 (1859).—SMITH, Rep. Geol. Surv. Ohio, IV, p. 676 (1882).—*Ancistrodon piscivorus*, COPE, Proc. Phila. Acad., 1859, p. 336.—COPE, Proc. Am. Philos. Soc., 1877, p. 64.—COPE, Bull. U. S. Nat. Mus., No. 17, p. 24.—COPE, Proc. U. S. Nat. Mus., XI, 1888, p. 393.—COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 683 (1892).—COUES and YARROW, Proc. Phila. Acad., 1878, p. 26.—TRUE, in Hammond's South Carolina, p. 235 (1883).—GARMAN, Rept. Batr. N. Am., I, pp. 121, 178 (1883).—GARMAN, Bull. Essex Inst., XXIV, p. 4 (1892).—BOETTGER, in Brehm's Thierleben, 3 ed., VII, p. 469 (1892).—H. GARMAN, Bull. Ill. State Lab. Nat. Hist., III, p. 315 (1892).—*Agkistrodon piscivorus*, JORDAN, Man. Vert. North. U. S., 5 ed., p. 199 (1888).—H. GARMAN, Bull. Ill. State Lab. Nat. Hist., III, p. 187 (1890).—H. GARMAN, Bull. Essex Inst., XXVI, p. 36 (1894).—HAY, Proc. U. S. Nat. Mus., XV, 1892, p. 386.—HAY, Batr. Rept. Indiana, p. 184 (1893).—LŒNNBERG, Proc. U. S. Nat. Mus., XVII, 1894, p. 336.

1802.—*Coluber aquaticus*, SHAW, Gen. Zool., III, p. 425.

1829.—*Trigonocephalus tisiphone*, CUVIER, Règne Anim., 2 ed., II (p. 89) (in part).

1836.—*Acontias leucostoma*, TROOST, Ann. N. Y. Lyceum Nat. Hist., III, p. 176.

1853.—*Toxicophis pugnax*, BAIRD and GIRARD, N. Am. Serp., pp. 20, 156.—HALLOWELL, Proc. Phila. Acad., 1856, p. 307.—BAIRD, Mex. Bound. Surv., II, Zool. Rept., p. 15 (1859).—*Ancistrodon pugnax*, COPE, Proc. Phila. Acad., 1859, p. 336.

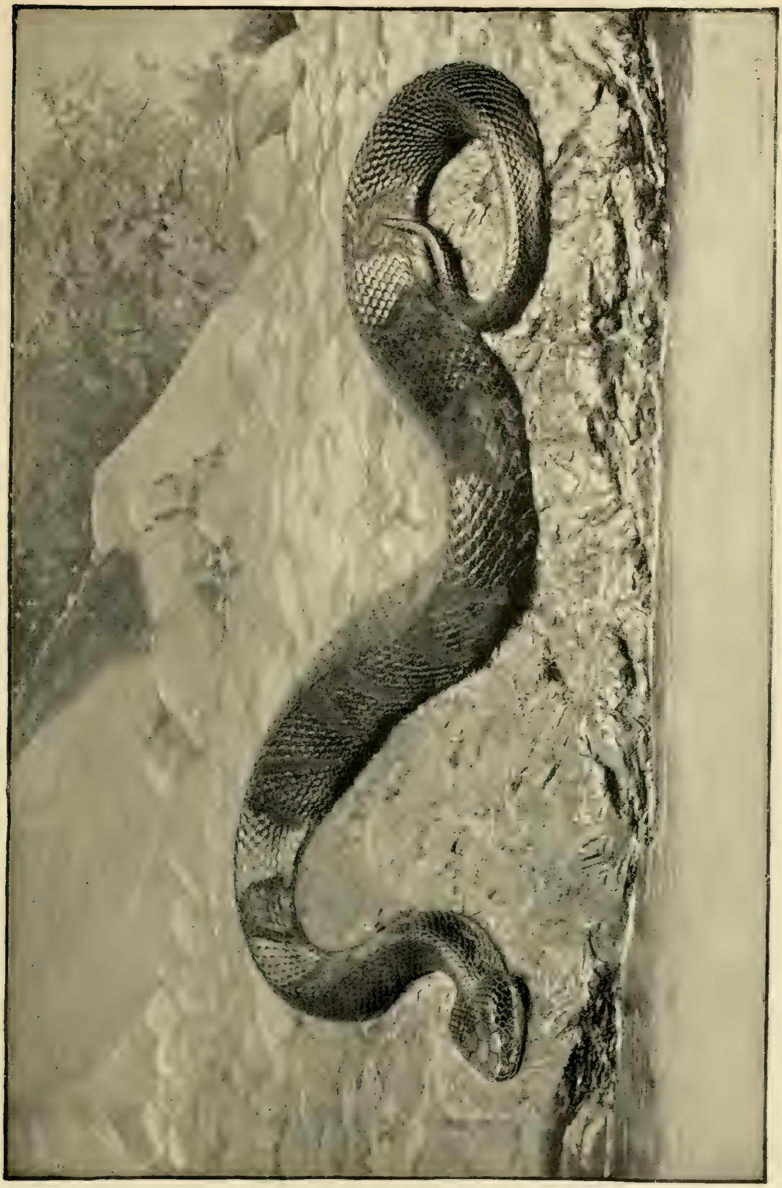
1854.—*Trigonocephalus atrofuscus*, HALLOWELL, in Sitgreave's Exp. Zuñi and Colo. Riv., p. 147 (not of Troost).

1863.—*Trigonocephalus piscivorus*, var. *pugnax* JAN, Elenc. Sist. Ofid., p. 125.—*Ancistrodon piscivorus*, subsp. *pugnax*, COPE, Bull. U. S. Nat. Mus., No. 1, p. 34.—GARMAN, Rept. Batr. N. Am., I, Ophid., p. 159 (1883).—YARROW, Bull. U. S. Nat. Mus., No. 24, pp. 12, 80 (1883).

1875.—*Ancistrodon piscivorus*, subsp. *piscivorus*, COPE, Bull. U. S. Nat. Mus., No. 1, p. 34.—YARROW, Bull. U. S. Nat. Mus., No. 24, pp. 12, 79 (1883).—DAVIS and RICE, Bull. Ill. State Lab. Nat. Hist., I, No. 5 (p. 28) (1883). DAVIS and RICE, Bull. Chic. Acad. Sc., I, p. 28 (1883).

Figures.—TROOST, Ann. N. Y. Lyc. Nat. Hist., III, 1836, pl. V.—HOLBROOK, N. Am. Herpet., 1 ed., II, pl. XIII (1838), 2 ed., III, pl. VII (1842).—BAIRD, Pac. R. R. Rep., X, Rept., pl. XXV, figs. 13, 14 (1859).—BAIRD, Mex. Bound. Surv., Zool. Rept., pl. VI (1859).—JAN, Icon. Ophid., livr. 46, pl. IV (1874).—BOCOURT, Miss. Sc. Mex., III, Zool., Rept., livr. 8, pl. XXVII (1882).—GARMAN, Rept. Batr. N. Am. I, Ophid., pl. VIII, fig. 2 (1883).—BREHM'S Thierleb., 3 ed., VII, p. 470 (1892).

* From the Latin *piscivorus*, at fish-eating.



WATER MOCCASIN,—AGKISTRODON PISCIVORUS.

From a cast in the U. S. National Museum.

*Description.**—No loral. Inferior wall of orbit constituted by third labial: 25 dorsal rows. Dark chestnut brown, with indistinct vertical dark bars. Line from superciliary along the edge of the head, through the middle of the second supralabial row. A second line from the lowest point of the orbit parallel to the first (figs. 43 and 44).

Scales all large and well developed; those on the sides and back of head conspicuously so. Two nasal plates, with the nostril between them. Anterior orbitals 2, one above the other, the upper extending from the eye to the posterior nasal, the lower linear and forming the upper wall of the pit. Lower and posterior wall of pit constituted by a narrow plate resting along the third labial and terminating on the second. Third labial very large, constituting the inferior wall of the orbit, of which 3 scales form the posterior. Upper labials 8, very large and broad; lower 10. Occipitals [parietals] terminated each by a triangular plate. All the scales on the back of the head carinated. Dorsal scales all carinated.

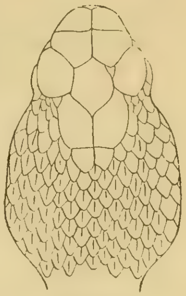


Fig. 43.
HEAD OF AGKISTRODON PISCIVORUS FROM ABOVE.
(After Baird.)

General color, dark chestnut-brown with darker markings. Head above, purplish black. An obsolete chestnut-brown streak passes from the posterior end of the superciliary along the upper edge of the head, through the middle of the second row of supralabial scales. A narrow yellowish white line passes from the third labial, or begins just below the lowest part of the orbit, and passing backward parallel with the first stripe crosses the angle of the mouth at the seventh labial and meets the first stripe on the side of the neck, where it is confluent with yellowish white of the throat. On the lower labial are 3 short, nearly vertical, light bars; on fourth, sixth, and seventh, the rest of the jaw itself, as well as the interval between the stripes on the sides of the head, dark purplish brown, of which color is also the space in front and below the eyes. General color above, dull dark chestnut-brown. On each side a series of 20 or 30 narrow, vertical, purplish black bars 1 or 2 scales wide. Of these, sometimes 2 contiguous to each other on the same side are united above into an arch, inclosing a space, the center of which is rather duskier than the ground color; at others, corresponding bars from the opposite sides unite and form half rings, encircling the body. Sometimes there is a lighter shade bordering the dark bars. Beneath, black, blotched with yellowish white.

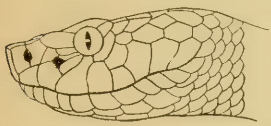


Fig. 44.
SAME FROM SIDE.

Number of ventrals [gastrosteges], 130 to 145; of subcaudals [urosteges], 39 to 45, of which divided, 0 to 21.

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* By S. F. Baird, in Baird and Girard's N. Am. Serp., p. 19.

Variation.—The supposed species, or subspecies, *A. pugnax*, was based upon an alleged different arrangement of the anterior supralabials in specimens from Texas, the second being crowded up from the commissure by the first and third. Later investigations of much additional material have shown that the character is very variable and entirely too unstable to serve as a foundation for a division.

The number of divided urosteges is also highly variable and seems to have no significance.

In the young specimens the colors are much lighter and the pattern better defined than in the adults.

Geographical distribution.—In the main, the Water Moccasin, or the Cotton-Mouth, as it is also often called from the whiteness of its mouth, has the same range in the United States as the harlequin snake, *Elaps fulvius*, extending as it does from North Carolina along the coast to the Mexican boundary, including the entire peninsula of Florida. It is also found a considerable distance up the Mississippi River and some of its southern tributaries.

In North Carolina it is found in several localities. We have specimens from Wilmington and New Berne, and Messrs. Brimley, of Raleigh, inform me that in the summer of 1891 one specimen over 3 feet long was taken on Neuse River, 1 mile above Milburne, some 6 or 8 miles east of Raleigh. According to Coues and Yarrow, it is very numerous in woods of Bogue banks on the mainland near wet and marshy places. Holbrook locates its northern limit at Pedee River. In the coast regions of South Carolina, Georgia, Alabama, and Mississippi it is very numerous, as well as over the whole of Florida as far as Key West. The same may be said of Louisiana, and Dr. Gustave Kohn informs me that the moccasin, or the Congo serpent, as it is called by the Creoles, is common even within the limits of the city of New Orleans. Along the Mississippi River it ascends into southern Missouri, Illinois, and Western Kentucky. In Illinois it occurs along the Wabash River at Mount Carmel, and Mr. Robert Ridgway assures me that trustworthy witnesses have told him of its former occurrence as far as Vincennes, in Indiana. On the west side it ascends the Arkansas River the entire breadth of the State of Arkansas, and seems to reach as far up as the boundary of Oklahoma Territory at least. In eastern Texas it follows the rivers into the interior even as far up as Dallas, where Cope regards it as still abundant, but in the western, more arid portion of the State it does not seem to go farther up than about the thirtieth parallel, though on the coast it is quite plentiful.

Habits.—Unlike the other Pit Vipers inhabiting the United States, the Water Moccasin, as the name implies, is distinctively a water snake. Holbrook, who had plenty of opportunity to observe its habits, writes that it is found about damp swampy places, or in water—far from which it is never observed. In summer, numbers of these serpents are

seen resting on the low branches of such trees as overhang the water, into which they plunge on the slightest alarm. Catesby, he continues, thinks they select these places to watch for their prey. They merely choose them in order to bask in the sun; for in those situations deprived of trees, as the ditches of rice fields, their basking places are often on dry banks. They are the terror of the negroes that labor about rice plantations, where they are more dreaded than the Rattlesnake, which only bites when irritated, or in self-defense, or to secure its prey; the water moccasin, on the contrary, attacks everything that comes within his reach, erecting his head and opening his mouth for some seconds before he bites.

Notwithstanding the fact that the poison of the Water Moccasin has been found proportionately less virulent than that of the Rattlesnake and the Copperhead, the fear it inspires is well founded, for it is a much larger and especially much heavier snake than the Copperhead. I do not know the extreme length to which it may grow, but it probably exceeds 4 feet considerably, as the largest specimen in the National Museum collection measures 45¾ inches (1.160 m.) with a circumference around the thickest part of the body of not less than 7½ inches (190 mm.). Records of cases of Moccasin bites are rather scarce, however, and the fatalities are probably not numerous. A serious case was recently reported to the writer by Mr. E. P. Alexander, of Georgetown, S. C., of a woman bitten in one finger. On September 26, 1893, he wrote again:

> The woman recovered, but suffered much for two weeks, flesh sloughing from finger, so that amputation of the finger, or even of the hand, was seriously considered by the attending physician.

The habits of the Water Moccasin have been studied very little in their native haunts, but as this Crotalid seems to bear captivity better than any of the others, there have been made very valuable observations in the Zoological Garden in Berlin by Rudolph Effeldt.* He obtained four specimens, which had been born in the Zoological Garden in London, and reared there with great success. They became exceedingly tame and gentle toward their keeper, who finally handled them without fear in an almost reckless manner. They would take the food, preferably fishes, but also other cold or warm blooded animals, or even raw meat, from the forceps in the hand of the keeper. Toward other snakes, including Rattlesnakes, they were very savage, and, curiously enough, their bite proved dangerous to other poisonous snakes, but not to others of their own species. They would often fight among themselves, chiefly for a place in the water basin or during the pairing season.

The pairing was observed by Effeldt repeatedly at various seasons, in spring, summer, and even in the autumn as late as October 10, and described by him in detail. A pair which he obtained in 1871 and

* Zool. Garten, xv, 1874 (pp. 1–5).

1872 paired on January 21, 1873, and on the following July 6 he found 8 recently-born young in the cage. They were about 260 mm. long by 15 mm. thick, and, unlike the parents, of a pale flesh color, with blackish brown zigzag bands. After the first molt, about two weeks after birth, the ground color became more reddish brown, and at the next one, about five weeks later, copper brown, the head being more brightly colored in all stages. This color lasted into the second year, when they gradually assumed the dark color of the parents. During the first two weeks they took no food, then they accepted young frogs, but refused fishes. At the end of two months they were 340 mm. long, with a proportionally large head. The parents seemed to show some affection for their offspring.

Genus SISTRURUS,* Garman.

THE GROUND RATTLESNAKES.

1822.—*Crotalus*, FLEMING, Philos. Zool., II, p. 294 (type *C. miliaris*) (not of Linn., 1758).

1825.—*Crotalophorus*, GRAY, Ann. Philos., 1825 (p. 205) (not of Houttuyn, 1764).

1826.—*Caudisona*, FITZINGER, N. Class. Rept., p. 34 (type *C. miliarius*) (not of Laurenti, 1768).

1883.—*Sistrurus*, GARMAN, N. Amer. Rept., I, Ophid., pp. 110, 176 (same type).

Between 1822 and 1826 several authors, led by Fleming, for the first time undertook to subdivide the old genus *Crotalus* into two genera according to the scutellation of the top of the head, but they were very unfortunate in adopting for the ground rattlers names which had been used before. Considerable confusion in the nomenclature of the rattlesnakes was the result, as partly pointed out under the head of *Crotalus*. S. Garman was the first to fully understand the situation, and, in 1883, to supply a tenable name for the genus of the ground rattlers. He has fully demonstrated the correctness of his position.†

The Ground Rattlesnakes form a small compact genus of only three species, one of which is confined to Mexico. Their distribution in the United States is rather curious, inasmuch that they are found in the eastern portion east of the Rocky Mountain region proper, although one form enters the Sierra Madre plateau, even occurring on the western slope of it in Arizona.

The two species inhabiting the United States occupy two distinct areas, which only overlap to a comparatively slight extent in the Indian Territory and adjacent region.

Synopsis of the species of Sistrurus found in the United States.

a^1. Prefrontals not in contact with the loreal proper (lower loreal, if two be present); a whitish stripe from posterior nasal below eye to angle of mouth (fig. 45).

 b^1. Number of scale rows usually 25.

  c^1. Spots larger .... *S. catenatus*

  c^2. Spots smaller .... ? *S. c. consors*

* From the Greek σεῖστρον (seistron), a rattle; οὐρά (oura), a tail.

† Science, XIX., May 20, 1892, p. 290.

b^2. Number of scale rows usually 23........................... *S. c. Edwardsii*

a^2. Prefrontals in contact with the loreal proper; a whitish stripe from below center of eye to angle of mouth (fig. 46)..................................... *S. miliarius*

Fig. 45.
HEAD OF SISTRURUS CATENATUS.
From side, showing color pattern.

Fig. 46.
HEAD OF SISTRURUS MILIARIUS.
From side, showing color pattern

A pretty good character in dubious cases between *S. catenatus* typical and *S. miliarius* consists in the pattern of the parietals, if visible.

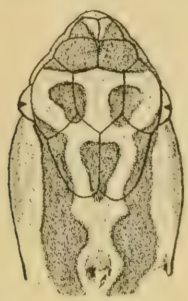


Fig. 47.
COLOR PATTERN OF TOP OF HEAD OF SISTRURUS CATENATUS.

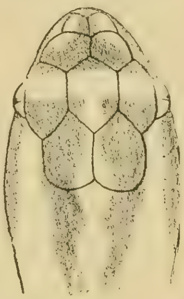


Fig. 48.
COLOR PATTERN OF TOP OF HEAD OF SISTRURUS MILIARIUS.

In the former there is a dark patch covering the center of the parietal suture (fig. 47), while in the latter the light portion forms a narrow band down the entire length of this suture (fig. 48).

THE MASSASAUGA.

*Sistrurus catenatus,** (Rafinesque).

Plate 5.

1818.—*Crotalinus catenatus*, RAFINESQUE, Amer. Monthl. Mag., IV, 1818, p. 41.—*Crotalus catenatus*, GARMAN, N. Am. Rept., I, Ophid., p. 118 (1883).—*Sistrurus catenatus*, GARMAN, N. Am. Rept. I, Ophid., p. 176 (1883).—JORDAN, Man. Vert. North. U. S., 5 ed., p. 199 (1888).—TAYLOR, Ann. Rep. Nebraska State Board Agric., 1891, p. 355 (1892).—OSBORNE, Part. Cat. Anim. Iowa, p. 9 (1892).—H. GARMAN, Bull. Ill. State Lab. Nat. Hist., III, p. 312 (1892).—H. GARMAN, Bull. Essex Inst., XXVI, 1894, p. 62.—HAY, Batr. Rept. Indiana, p. 126 (1893).—HURTER, Trans. Acad. Sc. St. Louis, VI, p. 258 (1893).—*Crotalophorus catenatus*, COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 685 (1892).—HAY, Proc. U. S. Nat. Mus., XV, 1892, p. 387.

1823.—*Crotalus tergeminus*, SAY, in Long's Exped. Rocky Mts., I, p. 499.—HARLAN, Journ. Phila. Acad., V, 1827, (p, 372).—HARLAN, Phys. Med. Res., p. 135, (1835).—DUMÉRIL ET BIBRON, Erpét. Génér., VII, ii, p, 1479 (1854).—COPE, in Mitchell's Res. Ven. Rattlesn., p. 125 (1861).—HAYDEN, Trans. Am.

* From the Latin *catenatus*, chained, chain-like.

Philos. Soc., XII, 1862, p. 177.—*Crotalophorus tergeminus*, GRAY, Synops. Rept., p. 78 (1830).—GRAY, Cat. Snakes Brit. Mus., p. 18 (1849).—HOLBROOK, N. Am. Herpet., 2 ed., III, p. 29 (1842).—DEKAY, Zool. N. Y., III, p. 57 (1842).—BAIRD and GIRARD, N. Am Serp., p. 14 (1853).—BAIRD, Serp. N. Y., p. 11 (1854).—GEBHARD, Sixth Rep., State Cab. Nat. Hist. N. Y., (p. 22) (1853).—KENNICOTT, Trans. Ill. State Agr. Soc. I., 1853-'54 (p. 592).—COPE, Proc. Phila. Acad., 1859, p. 336.—MAX V. WIED, Verz. Rept. Reise N. Amer., p. 74 (1865).—SMITH, Rept. Geol. Surv. Ohio, IV, p. 674 (1882).—HIGLEY, Trans. Wisc. Acad. Sc., VII, p. 161 (1884).—*Caudisona tergemina*, WAGLER, Nat. Syst. Amph., p. 176 (1830).—COPE, Bull. U. S. Nat. Mus., No. 1, p. 34 (1875).—COUES and YARROW, Bull. Geol. Geogr. Surv. Terr. (Hayden's), IV, 1878, p. 269.—CRAGIN, Trans. Kansas Acad. Sc., VII, p. 121 (1881).—DAVIS and RICE, Bull. Ill. State Labor. Nat. Hist., I, No. 5 (p. 28) (1883).—DAVIS and RICE, Bull. Chic. Acad. Sc., I, p. 28 (1883).—YARROW, Bull. U. S. Nat. Mus., No. 24, pp. 12, 79 (1883).—HAY, Amph. Rept. Indiana, p. 13, pl. II, fig. 15 (1885).—GARNIER, Proc. Canad. Inst. Toronto (3), V, 1888, (p 255).—GIBBS, Wolver. Natural., I, Feb., 1890, p. 12.—GIBBS, Forest and Stream, XXXIX, July 7, 1892, p. 7.

1838.—*Crotalus miliarius*, KIRTLAND, in Mather's Sec. Rep. Geol. Surv. Ohio, 1838, p. 167 (not of Linn).—W. L. SCLATER, Snakes, Ind. Mus., p. 74 (1891).

1838.—*Crotalus messasaugus*, KIRTLAND, in Mather's Sec. Rep. Geol. Surv. Ohio, 1838, p. 190 (footnote).

1842.—*Crotalophorus kirtlandi*, HOLBROOK, N. Am. Herpet., 2 ed., III, p. 31.—DE KAY, Zool. N. Y., III, p. 57 (1842).—GRAY, Cat. Snakes Brit. Mus., p. 18 (1849).—*C. kirtlandii*, BAIRD and GIRARD, Cat. N. Am. Serp., p. 16 (1853).—KENNICOTT, Trans. Ill. State Agr. Soc., I, 1853-'54 (p. 592).—COPE, Proc. Phila. Acad., 1859, p. 336.

1850.—*Crotaphorus*, sp., AGASSIZ, Lake Superior, p. 381.

1854.—*Crotalophorus massasauga*, BAIRD, Serp. N. York, p. 12.

1882.—*Crotalophorus tergeminus*, var. *kirtlandii*, SMITH, Rep. Geol. Surv. Ohio, IV, p. 674.—HIGLEY, Trans. Wisc. Acad. Sc., VII, 1884, p. 161.

1882.—*Crotalophorus catenatus catenatus* COPE, Proc. U. S. Nat. Mus., XIV, 1891 (No. 882), p. 685.—TAYLOR, Amer. Natural., XXVI, Sep., 1892, p. 752.

Figures.—HOLBROOK, N. Am. Herpet., 2 ed., III, pll. V, VI (1842).—AGASSIZ, Lake Superior, pl. VI, figs. 6-8 (1850).—DUMÉRIL and BIBRON, Erpét. Génér., Atlas, pl. LXXXIV *bis*, fig. 5 (1854).—BAIRD, Pac. R. P. Rep., X, Rept., pl. XV, figs. 9, 11 (1859).—GARMAN, Rept. Batr. N. Am., I, pl. IX, fig. 2 (1883).

*Description.**—Twenty-five rows of dorsal scales, strongly carinated, with the exception of the first row, which is perfectly smooth. Vertical

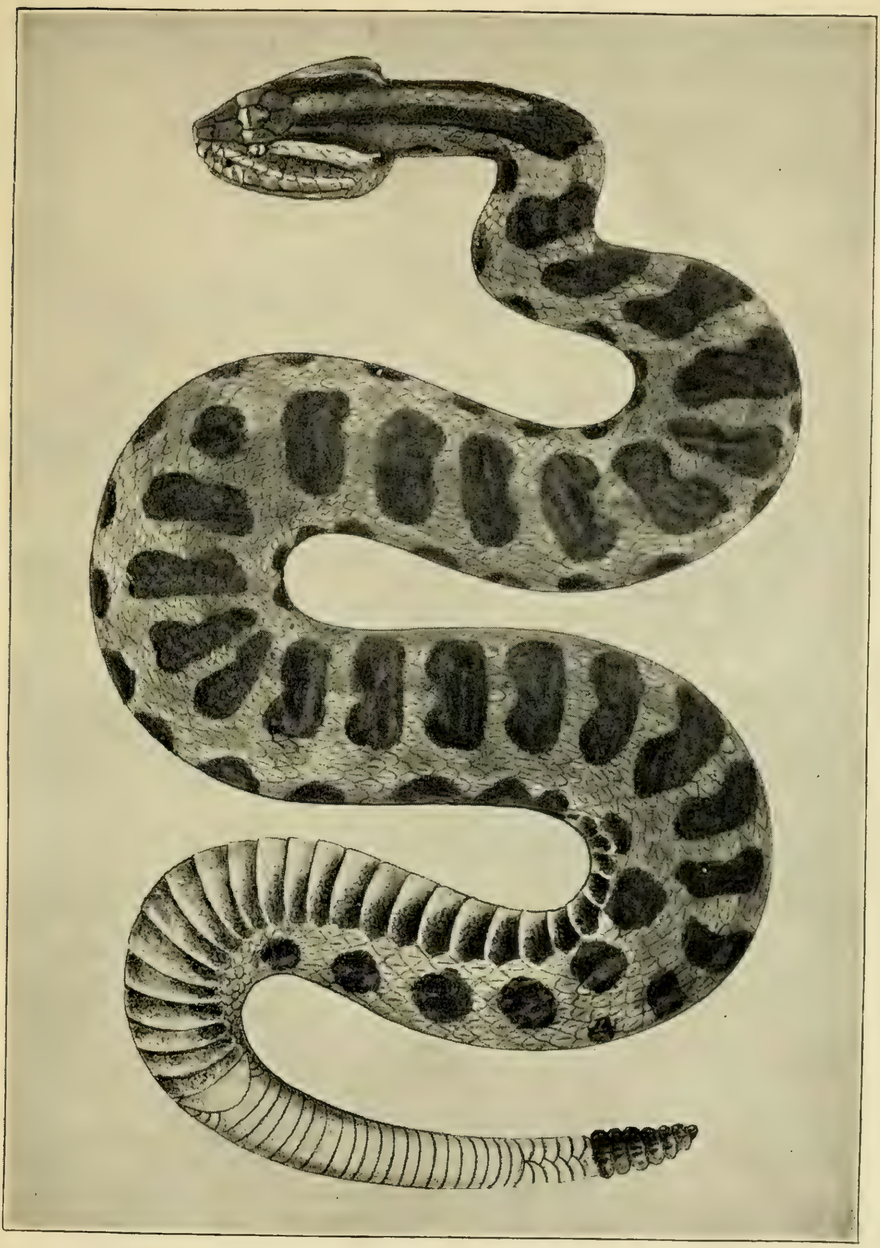
Fig. 49.

Fig. 50.

HEAD OF SISTRURUS CATENATUS, SHOWN FROM TOP AND SIDE.

plate [frontal] subhexagonal, pointed posteriorly. Seven longitudinal series of blotches. A narrow band of yellowish white extends from the pit to the neck in passing close to the angle of the mouth (figs. 49, 50).

* By C. Girard, in Baird and Girard's N. Am. Serp., p. 14, from specimens from Wisconsin, Michigan, and Ohio.



MASSASAUGA,—SISTRURUS CATENATUS.
From Holbrook, North Am. Herpetology.

The ground color above is brown; the blotches are deep chestnut-brown, blackish externally, and with a yellowish-white margin. The dorsal blotches are 34 in number from the head to the region opposite the anus, 26 of which are transversely and irregularly oblong, anteriorly and posteriorly emarginated—less so, however, posteriorly; 8 are sub-circular. Five or 6 exist on the tail from the anus to its tip, extending on the sides, the last two forming sometimes a complete ring. The next series on either side is composed of small blotches, but as intensely colored as in the other series. They alternate with the dorsal ones. They have no regularity either in outline or position. The second lateral row is composed of the largest lateral blotches. They are transversely oblong or oval on the second, third, fourth, fifth, and sixth rows of scales, and opposite the blotches of the dorsal series; consequently alternating with third series above. The first lateral series again is composed of blotches intermediate in size between those of the third and second series; they occupy the first and second rows of scales, and extend somewhat to the abdominal scutellæ [ventrals, or gastrosteges], and alternating with the adjoining series. Two undulated vittæ extend from the supraorbital plates along the neck to the first dorsal blotch, and often confluent with the latter. A linear vitta margined with yellowish white extends from the posterior edge of the eye to the sides of the neck; the inferior yellow margin is the broadest, and passes from the pit close to the angle of the mouth, turning forward to the middle of the lower jaw, inclosing a semielliptical brown patch. Two elongated yellowish spots may be observed diverging from both sides of the pit to the lip. The cephalic plates are deep chestnut-brown; a transverse light brown band extends across the head from one orbit to the other.

Variation.—The ground color varies from brownish gray, through brown, to blackish, the latter being the so-called *C. kirtlandi.* It appears that specimens living in swamps and marshy places are chiefly of the latter color. The alleged differences in the shape of the head between Ohio and Wisconsin specimens (Smith, *loc. cit.*) I have been unable to verify.

Geographical distribution.—The area inhabited, now or formerly, by the Massasauga lies approximately between the seventy-seventh and ninety-eighth meridians and the thirty-eighth and forty-fifth parallels.

In the State of New York they have been found in Genesee County, in the western portion, draining into Lake Ontario, where their occurrence in the town of Byron was recorded for the first time in 1853 by Mr. John Gebhard. They then inhabited a white-cedar swamp containing an area of about 1,000 acres. In Ohio, whence came the types of Kirtland's *C. messasaugus* (or Holbrook's *C. kirtlandi*), they are presumed to occur in all parts. It is also common in parts of Michigan, though it must be remembered that this expression "common" in all these snakes is a very indefinite term. The accessible record may show them to have been common in a given place at the time

it was made, yet at the present day one may search long and often in the same place and not find one. Dr. Hay says that it is yet abundant in some localities in Indiana, but he has not been able to confirm its occurrence south of Indianapolis. He also states that on the prairies of Illinois, before the country became thickly populated, they were extremely abundant, and the killing of two or three dozen of them in a season was not an unusual thing for any farmer's boy, while now, in that same region, not one is seen in years. H. Garman states that it occurs on the prairies throughout Illinois, but I can find no reliable records for the southern part. The only place where Hurter has found it there is the "Wet Prairie," near Edwardsville, Madison County, where they seem to be common, however. The massasauga also occurs in suitable localities in Wisconsin, Minnesota, and Iowa. Taylor quotes it as common in eastern and middle Nebraska, and the record for Kansas is similar. Farther in the Southwest it is replaced by *S. edwardsii.* In the Northeast the Massasauga extends into Canada, where it occurs in various localities in the peninsula of Ontario. The National Museum has a specimen from Lucknow, by Dr. Garnier (No. 12752), and Mr. James M. Macoun informs me that he knows of specimens from Georgian Bay, Lake Huron, and Pelee Point, Lake Erie.

Habits.—The Massasauga is emphatically a species of the prairies and their swamps and marshes. Its life history offers as yet some unsolved or disputed questions, but thanks to Dr. O. P. Hay's interesting studies of this species, much light has of late been thrown upon it, and to those who want a more detailed biography I would recommend his article, "The Massasauga and its Habits," in the American Naturalist (Vol. XXI, 1887, pp. 211–218), which also contains some interesting observations on two specimens which brought forth living young—one five, the other six—in captivity.

Being a comparatively small species, the maximum length probably not exceeding 40 inches, its bite is correspondingly less dangerous than the larger Rattlesnakes. There seems to be great diversity of opinion, however, as to the extent of its poisonous power, for while Dr. Kirtland asserts that the bite is scarcely more than the sting of a hornet, the farmers fear it very much, and Dr. Hay thinks that one Massasauga would probably be equivalent in virulence to a whole colony of hornets, which I think is more nearly correct.

Dr. Hay also characterizes the statement that the sound of the rattle of the Massasauga is so feeble that it is scarcely audible, as certainly incorrect, asserting from experience that it can be heard at a distance of several feet. Dr. Morris Gibbs, who has examined a great many specimens, found the largest number of rings in the rattle to be 10. The largest number in any specimen in the National Museum is 9 (No. 12752).

Dr. Taylor, writing of the Massasauga in Nebraska, states that an examination of the contents of the stomachs of this species shows that

its food is almost wholly made up of mice and other rodents, and he consequently considers it decidedly useful, aside from its venomous qualities. It seems hardly advisable, however, to suggest protection for this species on this account, but I would advise that the farmers spare the life of every large harmless snake on their land, and there would be no harm in killing off every Rattler, for harmless snakes will destroy the mice fully as well as the poisonous ones.

THE GULF-COAST MASSASAUGA.

Sistrurus catenatus consors,* (B. & G.).

1853.—*Crotalophorus consors*, BAIRD and GIRARD, Cat. N. Am. Serp., p. 12.—DUMÉRIL and BIBRON, Erpét. Génér., VII, ii, p. 1482 (1854).—BAIRD, Pac. R. R. Rep., X, Reptiles, p. 14 (1859).

1883.—*Sistrurus catenatus*, var. *consors*, GARMAN, Rept. Batr. N. Am., I, Ophid., p. 176.

1892.—? *Sistrurus catenatus*, GARMAN, Bull. Essex Inst., XXIV, p. 4.

Figure.—BAIRD, Pac. R. R. Rep., X, Rept. pl. XXIV, fig. 8 (1859).

The status of the present form is very doubtful. It was described by Baird and Girard from a single specimen collected at Indianola, Tex., which now appears to be lost. The original description does not furnish any very tangible character by which to separate it from typical *S. catenatus* with 25 scale rows, but its scutellation is compared chiefly with *S. miliarius*, which seems to indicate that it may have had the preocular and posterior nasal separated, although the otherwise so characteristic color pattern of the head is that of *S. catenatus*. The figure in the Pacific Railroad Report [pl. XXIV, fig. 8], gives only the top of the head, but the above suggestion is strengthened by that figure, which certainly seems to show a separation of the shields mentioned by a loreal, but whether by an upper loreal, detached from the anterior portion of the preocular, or by a large loreal proper, is not clear, although the former alternative seems most probable. In that case we have probably to do with an individual variation only, and the only ground for the separation of the subspecies would be the smallness of the dorsal spots. The 25 scale rows would then distinguish it from the subspecies *S. c. edwardsii*.

I am inclined to think that the *S. catenatus* reported by Garman (Bull. Essex. Inst., XXIV, 1892, p. 4.) from Deming's Bridge, Matagorda County, Tex., not very far from the type locality of *S. consors*, and which, like the latter, had 25 scale rows, belong here. They have, moreover, 48 to 51 dorsal blotches.

For the sake of completeness, I add the original description by C. Girard.

Description.—Twenty-five rows of dorsal scales, all carinated except the two first rows on either side. Seven series of blotches, one dorsal and 3 on each side, all very small. A yellowish white line passing from behind the nostril below and behind the eye.

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*From the Latin *consors*, a partner, companion, or relative.

Resembles *C. miliarius* in its general appearance, but without the vertebral brownish red line. The ground color is olivaceous brown, the blotches of a deeper brown, encircled with a black fillet margined with a whitish yellow line. There are about 50 blotches in the dorsal series, emarginated anteriorly only, 30 of which are transversely elongated, very irregular; the 20 remaining ones nearly circular, with regular outlines. The blotches of the lateral rows are comparatively small and of nearly equal size, though sometimes one of either row may appear much the largest. The blotches of the first lateral series are opposite to those of the dorsal and affect the first, second, and third rows of scales and the extremities of the abdominal scutellæ [ventrals, or gastrosteges]. The blotches of the second series alternate with these, extending on the third, fourth, and fifth rows of scales. The blotches of the third series are obsolete and alternate with those of the second series, and are generally opposite to those of the dorsal series situated in the fifth, sixth, and seventh rows. The upper surface of the head is brown; there are 2 vittæ extending from the vertex along the neck to the first dorsal blotch. A broader and deep chestnut-brown band extends from the eye to the neck. The frontal region is deeper brown than the vertex. A yellowish white line starts from the nostrils near the upper surface of the head, extending backward, in passing between the eye and the pit, to the angle of the mouth. A vertical whitish bar extends from each side of the pit to the labial. The belly is yellowish white, marbled with black, transversely oblong patches. The vertical plate [frontal] is cordiform; the anterior frontal plates [internasals] proportionally small; the occipital [parietal] rather broad. The scales of the body are elongated, a little smaller than in *C. miliarius*, but not quite so acute posteriorly. The 2 lateral and smooth rows are much broader than the rest, and conspicuous. Most of the scales of these 2 rows are black, with the posterior edge straw-colored, giving the appearance of a succession of distinct crescents. The tail is conical and tapering; the rattle composed of one ring besides the terminal one.

EDWARDS' MASSASAUGA.

Sistrurus catenatus edwardsii,* (B. & G.).

Plate 6.

1853.—*Crotalophorus edwardsii*, BAIRD and GIRARD, Cat. N. Am. Serp., p. 15.—DUMÉRIL et BIBRON, Érpét. Gén., VII, ii, p. 1483 (1854).—BAIRD, U. S. Mex. Bound. Surv. Rept., p. 15 (1859).—*Caudisona edwardsii*, COPE, Bull. U. S. Nat. Mus. No. 1, Check list, p. 34 (1875).

1874.—*Crotalus miliarius*, JAN, Icon. Ophid., livr. 46, pl. III, fig. 6 (not of Linn).

1883.—*Sistrurus miliarius*, var. *edwardsii*, GARMAN, Rept. Batr. N. Am., I, Ophid., p. 177.

1892.—*Crotalophorus catenatus edwardsii*, COPE, Proc. U. S. Nat. Mus., XIV, 1891, No. 882, p. 685.—COPE, Proc. Phila. Acad., 1892, p. 336.

* Named in honor of Dr. L. A. Edwards, U. S. A.

EDWARDS' MASSASAUGA,—SISTRURUS CATENATUS EDWARDSII.

From Baird, Rep. Mex. Bound. Surv.

Figures.—BAIRD, Mex. Bound. Surv., II, Rept., pl. V, fig. 1 (1859).—BAIRD, Pac. R. R. Rep., X, Rept., pl. XXV, fig. 10 (1859).—JAN, Icon. Ophid. livr. 46, pl. III, fig. 6 (1874).

*Description.**—Twenty-three rows of dorsal scales; first and second lateral rows smooth. Vertical plate [frontal] subpentagonal, tapering posteriorly. Lateral rows of blotches proportionally very small.

The ground-color is yellowish brown, with three lateral series of deep chestnut-brown blotches. Two elongated brown blotches extend from the superciliaries [supraoculars] backward. A narrow band of chestnut brown, from the posterior frontal plates [prefrontals], passes over the eyes to the neck, under which a yellowish stripe extends from the nostril to the angle of the mouth. The snout and upper jaw are brown, with two yellow fillets diverging from the pit. The lower jaw and chin are mottled with brown and yellow. There are about 42 dorsal brown and irregular blotches, margined with deep black and encircled with a yellow fillet, from the head to the tip of the tail, the thirty-fourth opposite the anus, the last three passing to the sides of the tail, but do not meet below. Subcircular on the posterior half of the body, the blotches on the anterior half are longer transversely than longitudinally, emarginated anteriorly only.

The blotches of the two lateral series are proportionally small. The blotches of the upper series are more or less obsolete, and alternate with the dorsal ones. Those of the second lateral series are the smallest, and alternate also, being of as deep a color as the dorsal ones, but do not extend beyond the anus, occupying the second, third, and fourth rows of scales. The first and lower series affect the first and second rows and only one scale. The belly is of a light straw color, dotted and sprinkled irregularly with brown.

Scales elliptical, subtruncated posteriorly, constituting 23 rows, strongly carinated, except the two lateral rows, which are smooth

Head, when seen from above, subelliptical; vertical plate [frontal] proportionally more elongated than in *C. tergeminus* [= *S. catenatus*].

Number of ventrals [gastrosteges], 143 to 153; of caudals [urosteges], 24 to 31; scale rows across middle of body, 23.

Variation.—The chief variation in scutellation I have found in this subspecies consists in the occasional separation of the anterior prolongation of the preocular so as to form an upper loreal separating the preocular from the posterior nasal.

In coloration there is considerable difference between the specimens, chiefly consisting in an obliteration of the markings on top of the head, thus obscuring the characteristic dark spot on the middle of the parietal suture.

Geographical distribution.—The present subspecies represents the typical Massasauga in the Southwest. Curiously enough it does not

*Original description by C. Girard in Baird and Girard's N. Am. Serp., p. 15, from specimens Nos. 506-508, U. S. Nat. Mus.

extend further north than the southern limit of the latter. It is found from Indian Territory through western Texas to the Mexican border. Its known range has recently been extended a considerable distance west, as Dr. Timothy E. Wilcox has sent a specimen from Fort Huachuca, Ariz.

Habits.—Nothing is definitely known, but the habits are probably similar to those of the typical form, though it may have to be satisfied with more arid localities.

THE GROUND RATTLESNAKE.

Sistrurus miliarius,* (Linnæus).

Plate 7.

1766.—*Crotalus miliarius*, LINNÆUS, Syst. Nat., 12 ed., I (p. 372).—DAUDIN, Hist. Nat. Rept., V, p. 328 (1803).—SAY, Am. Journ. Sc., I, 1819, p. 263.—HARLAN, Journ., Phila. Acad., V, 1827 (p. 370).—HARLAN, Phys. Med. Res. (p. 134) (1835).—SCHLEGEL, Ess. Phys. Serp., I, p. 193; II, p. 569 (part) (1837).—HOLBROOK, N. Am. Herpet., 1 ed., II, p. 73 (1838).—DUMÉRIL et BIBRON, Erpét. Génér., VII, ii, p. 1477 (1854).—JAN, Rev. Mag. Zool., 1859, extr., p. 28.—JAN, Elenc. Sist. Ofid., p. 124 (1863).—COPE, in Mitchell's Res. Ven. Rattlesn., p. 124 (1861).—GARMAN, Rept. Batr. N. Am., I, Ophid., p. 119 (1883).—*Crotalophorus miliarius*, GRAY, Ann. Philos., 1825 (p. 205).—GRAY, Cat. Sn. Brit. Mus., p. 17 (1849).—HOLBROOK, N. Am. Herpet., 2 ed., III, p. 25 (1842).—DE KAY, Zool. N. Y., III, p. 57 (1842).—BAIRD and GIRARD, Cat. N. Am. Serp., p. 11 (1853).—LE CONTE, South. Med. Surg. Journ., IX, 1853, pp. 651, 652.—HALLOWELL, in Sitgreave's Exp. Zuñi Colo. Riv., p. 147 (1854).—BAIRD, Pac. R. R. Rep., X, Whipple's Route, p. 40 (1859).—COPE, Proc. Phila. Acad., 1859, p. 336.—COPE, Proc. U. S. Nat. Mus., XI, 1888, p. 393.—PUTNAM, Amer. Natural., II, 1868, p. 134.—HAY, Proc. U. S. Nat. Mus., XV, 1892, p. 388.—*Caudisona miliaria*, FITZINGER, N. Class. Rept., p. 63 (1826).—*C. miliarius*, GRAY, Zool. Miscell., p. 51 (1842).—COPE, Bull. U. S. Nat. Mus., No. 1, Check list, p. 34 (1875).—COPE, Proc. Am. Philos. Soc., XVII, 1877, p. 64.—COPE, Bull. U. S. Nat. Mus., No. 17, p. 24 (1880).—COUES and YARROW, Proc. Phila. Acad., 1878, p. 26.—TRUE, in Hammond's South Carolina, p. 235 (1883).—YARROW, Bull. U. S. Nat. Mus., No. 24, pp. 12, 78 (1883).—*Sistrurus miliarius*, GARMAN, N. Am. Rept., I, Ophid., p. 177, (1883).—GARMAN, Bull. Essex Inst., XIX, 1887, p. 123.—GARMAN, Bull. Essex Inst., XXIV, 1892, p. 4.—LŒNNBERG, Proc. U. S. Nat, Mus., XVII, 1894, p. 335.

1799.—*Crotalus miliaris*, BEAUVOIS, Trans. Am. Philos. Soc., IV, p. 367.

Figures.—CATESBY, Carol., II (pl. XLII) (1743).—SCHLEGEL, Ess. Phys. Serp., Atlas, pl. XX, figs. 17, 18 (1837).—HOLBROOK, N. Am. Herpet., 1 ed., II, pl. XV (1838).—HOLBROOK, N. Am. Herpet., 2 ed., III, pl. IV (1842).—BAIRD, Pac. R. R. Rep., X, Rept., pl. XXIV, fig. 7 (1859).

Description.†—Twenty-two or 23 dorsal rows of scales, all of which are carinated, the lateral and first row but slightly; a vertebral brownish red line; 7 series of blotches, 1 dorsal and 3 lateral, on each side, the uppermost of which is obsolete, and the lowest subject to irregular-

* From the Latin *miliarius*, millet-like, with millet-like spots.

† Description by C. Girard, in Baird and Girard's N. Am. Serp., p. 11, from specimens Nos. 498–502, U. S. Nat. Mus.

GROUND RATTLESNAKE,—SISTRURUS MILIARIUS.

From a cast in the U. S. National Museum.

ities. Vertical plate [frontal] subcordiform, occipital [parietal] oblong and elongated. A narrow white line commences at the lowest point of the orbit and passes obliquely backward to the angle of the mouth. Ground color dark grayish ash, minutely mottled. A series of 38 to 45 subcircular dorsal blotches extending from head to tail, dark brown, each with a narrow, distinct yellowish border. Interval rather narrower than the spots themselves. A broad band of purplish red passes from head to tail through the blotches. On each side may be distinguished three series of blotches, the first on the first and second lateral rows of scales and partly on the abdominal scutellæ [ventrals or gastrosteges]; the second alternating with this on the second, third, fourth, and fifth rows of scales, and opposite the dorsal series; the third alternating with the second and the dorsal series on the fifth, sixth, seventh, and eighth rows of scales. The latter series is dusky and obsolete; the others are uniform and distinctly black.

The shape of the blotches is subjected to some variation, according to individuals. Generally subcircular or slightly oblong, they become sometimes a transversely elongated quadrangle, three times as long as wide. Their shape varies according to the region of the body on which they are found. On the anterior third they are subquadrangular, anteriorly and posteriorly emarginated; on the middle region they elongate, and toward the posterior third become nearly circular. Backward of the arms the five or six blotches of that region extend on the sides, without, however, meeting on the lower surface. The blotches of the first lateral row are subquadrangular and a little smaller than those of the second and third rows, the blotches of the second row being transversely oblong and largest on the middle region of the body. Side of the head purplish brown, a narrow, distinct white line from the lowest part of the orbit passing obliquely backward to the angle of the mouth. Above and continuous with that white line a deep chestnut-brown vitta is observed, of the same length but broader, and lined above with a narrow, dull, yellowish margin. Two undulated dark brown vittæ extend from the vertex to the first dorsal blotch and confluent with it. A double crescentic blotch is observed on the frontal scutellæ [internasals and prefrontals], leaving a transversal fulvous band across the head between the orbits. The color underneath is reddish yellow, marmorated with brownish black blotches and minute dots.

The scales are elongated, carinated, and acute posteriorly. Those of the lateral row are slightly carinated also, but narrower than in *C. consors*, and more acute posteriorly.

Number of ventrals [gastrosteges], 132 to 136; of caudals [urosteges], 27 to 36; scale rows, 21 to 23.

The greatest number of joints to any rattle of this species in the U. S. National Museum is nine.

Variation.—While the scutellation of this species appears rather constant, there is considerable variation in color, inasmuch as speci-

mens from moist localities appear much darker, often quite blackish with large spots, while in those from more arid districts the ground color is much paler, and the markings more restricted. There is also a certain amount of variation with regard to the red dorsal stripe, which seems to be wanting in the young.

Geographical distribution.—Holbrook asserts that on the Atlantic coast this species does not occur north of the thirty-fifth parallel, and I am aware of no later record which contradicts this. In fact, the most northerly record I have been able to find seems to be that of Drs. Coues and Yarrow (Proc. Phila. Acad., 1878, p. 26) from the neighborhood of Fort Macon in North Carolina, a little south of the latitude mentioned. They write that a few individuals are said to have been seen on Bogue banks; none, however, observed or secured by them; but that they are quite common on Shackleford banks, a few miles from Fort Macon, and that it has also been taken on the mainland. The ground rattler is found south of this point along the coasts of North Carolina, South Carolina, Georgia, and Florida. In the latter State it is distributed all over the peninsula and along the Gulf coast to Alabama, Mississippi, and Louisiana. It ascends the Mississippi River Valley and the valleys of its southern tributaries, but curiously enough seems to be more common on the western side of the great river, being apparently common in Arkansas and Indian Territory even as far west as central Oklahoma, whence the National Museum has a young specimen collected by Dr. Edward Palmer at Old Fort Cobb.

In Texas Prof. Cope has recorded it as occurring at Dallas; Mr. Ragsdale has collected it in Cooke County, and Capt. Pope brought a specimen (No. 494) home from the head waters of the Colorado River, at about the one hundred and first meridian. On the coast of Texas Mr. Garman has recently recorded it (Bull. Essex Inst., XXIV, 1892) from Matagorda County.

Habits.—The Ground Rattler appears to prefer dry ground, and Holbrook states that it is found among leaves, and frequently in high grass in search of small field mice, on which it feeds.

The only observation about its breeding habits of which I am aware is a note by Prof. F. W. Putnam in the American Naturalist (Vol. II, 1868, p. 134) that he had once dissected a specimen having 14 eggs, all with embryos two inches in length in the oviduct.

According to Holbrook the common people dread the ground rattler and consider it much more destructive than the Banded Rattlesnake, both on account of its greater aggressiveness, the scant warning its faint rattling affords, and the supposed greater activity of its venom. He, however, satisfied himself by experiments of the fallacy of the alleged greater virulence of its poison, for while he found it sufficient to kill small birds, or field mice, repeated bites failed to affect a cat beyond causing it to droop for thirty-six hours, at the end of which time the effects of the poison entirely disappeared.

While thus the bite of these small snakes may be attended with com-

paratively little danger, a person bitten would act very foolishly were he to neglect to pay proper attention to the wound and to apply as soon as possible proper remedies, as otherwise he might pay dearly enough for his carelessness.

Although, as a rule, not fatal to man, the Ground Rattler is not harmless enough to secure it against destruction wherever it may be found. It is undoubtedly useful in destroying a great quantity of small rodents, but the protection of the other innocuous snakes will compensate for the killing of any number of Ground Rattlers.

Genus CROTALUS* Linn.

The Rattlesnakes.

1758.—*Crotalus*, Linnæus, Syst. Nat., 10 ed., i, p. 214 (type *C. horridus*).
1764.—*Crotalophorus*, Houttuyn, Linn. Natuurl. Hist., vi, p. 290 (emend.).
1768.—*Caudisona*, Laurenti, Syn. Rept., p. 92 (same type).
1818.—*Crotalinus*, Rafinesque, Am. Month. Mag., iii (p. 446), iv, p. 41 (emend.).
1830.—*Uropsophus*, Wagler, Syst. Amph., p. 176 (type *C. triseriatus*).
1843.—*Urocrotalon*, Fitzinger, Syst. Rept., p. 29 (type *C. durissus* Linn.).
1861.—*Aploaspis*, Cope, Proc. Phila. Acad., 1861, p. 206 (type *C. lepida*).
1875.—*Æchmophrys*, Coues, Wheeler's Surv. W. 100 Mer., v, p. 609 (type *C. cerastes*).
1883.—*Haploaspis*, Cope, Proc. Phila. Acad., 1883, p. 13 (emend.).

There has, at various times, been some confusion in the application of the generic terms of this and the following genus. From 1861 to 1875 Prof. Cope used Laurenti's *Caudisona* for the present group, restricting *Crotalus* to the Ground Rattlers, following Fleming's example of 1822. In 1875, however, he suddenly reversed the two names, employing *Caudisona* for the Ground Rattlers. This latter has later been exchanged for *Crotalophorus*, as will be shown under the following genus.

The case is very simple. When Linnæus, in 1758, first applied the binominal nomenclature he did not know or name any of the ground rattlers, consequently the name *Crotalus* can only be used as done here. Houttuyn's *Crotalophorus* is identical with Linnæi *Crotalus* of the tenth edition of his Systema Naturæ, being, in fact, simply an emendation and, therefore, nothing but a synonym. The status of Laurenti's *Caudisona* is exactly similar.

The geographical distribution of the genus *Crotalus* is highly interesting.

Jointly with the other genus, *Sistrurus*, the Rattlesnakes are peculiar to the New World. Their center of distribution appears to be the tableland of Mexico with its extension northward into the southwestern United States, at least 8 out of a total of the 17 species constituting the genus *Crotalus* occurring at, or near, the boundary between the United States and the Mexican Republic.

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* From the Greek κρόταλον (Krotalon), a rattle.

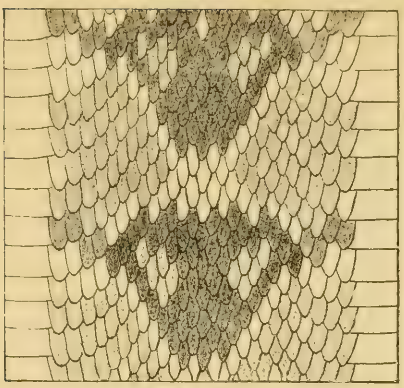

Fig. 51.
DORSAL COLOR PATTERN OF CROTALUS MOLOSSUS.

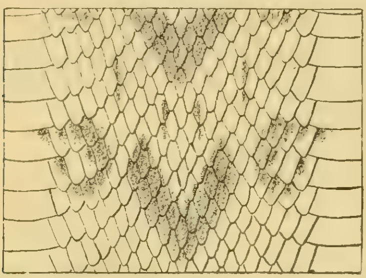

Fig. 52.
DORSAL COLOR PATTERN OF CROTALUS HORRIDUS.

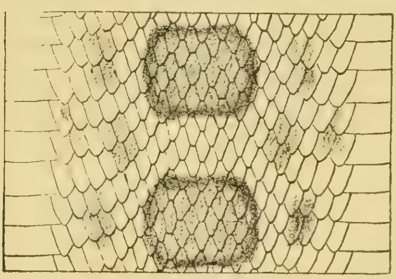

Fig. 53.
DORSAL COLOR PATTERN OF CROTALUS CONFLUENTUS.

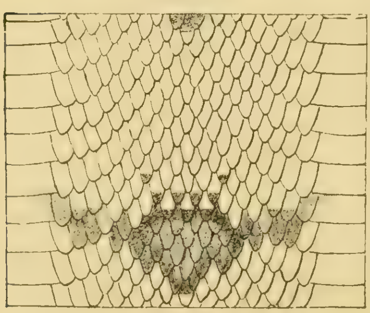

Fig. 54.
DORSAL COLOR PATTERN OF CROTALUS LEPIDUS.

No rattlesnake occurs in any of the West India Islands proper, and only one species appears to be confined to South America, where also another species occurs, the range of which, however, extends into southern Mexico.

Within the United States not less than ten species, with several subspecies, are found; but their distribution within that area is very uneven. Thus, while there are but few localities in which Rattlesnakes do not occur, or did not occur before they were exterminated by man, yet the area inhabited by more than one species of *Crotalus* is comparatively very limited. Thus in the southeast the range of the Diamond Rattlesnake, *C. adamanteus*, is overlapped to a great extent by that of the Banded Rattlesnake, *C. horridus*, while in the center of the Union there is another limited area inhabited by two species, viz, the Banded Rattlesnake, *C. horridus*, and the Prairie Rattler, *C. confluentus.*

As we approach the Mexican boundary and the northward extension of the Sierra Madre the density of the distribution of the species increases rapidly, until in southern Arizona we find no less than 7 different species of Rattlesnakes, viz: *C. molossus*, *C. atrox*, *C. confluentus*, *C. tigris*, *C. cerastes*, *C. lepidus*, and *C. mitchellii pyrrhus*, out of a total of 10 species inhabiting the entire area of the United States.

North of our northern boundary only two species of *Crotalus* extend a short distance into the British possessions, in the western part *C. lucifer* and in the central portion *C. confluentus.*

Fig. 55.

HEAD OF CROTALUS, FROM SIDE.

i Infralabials; *l* loreal; l^1 lower loreal; l^2 upper loreal; n^1 anterior nasal; n^2 posterior nasal; *p* preocular; *r* rostral; *s* supralabials; s^1 1st supralabial; s^2 2d supralabial; *so* supraocular.

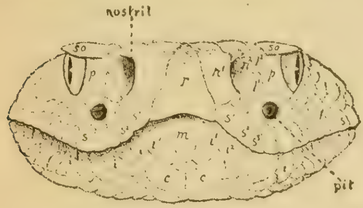

Fig. 56.

FRONT VIEW OF PRECEDING FIGURE.

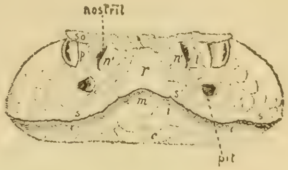

Fig. 57.

HEAD OF CROTALUS MITCHELLII FROM FRONT.

(See explanation of Fig. 55.)

Synopsis of the species of Crotalus occurring in North America north of Mexico.

a^1 Anterior nasal in contact with rostral (figs. 55, 56).
  b^1 Upper preocular not divided vertically (figs. 55, 56).
    c^1 External border of supraocular not produced into a horn-like process (figs. 55, 56).
      d^1 Dark spots on back with two symmetrical light spots, one on each side of median line (fig. 51) .... *C. molossus.*
      d^2 Dark spots on back, solid, or with only one median light spot.
        e^1 Dorsal pattern, consisting of dark chevron bands (fig. 52) ...... *C. horridus.*
        e^2 Dorsal pattern, consisting of more or less squarish spots or straight cross bands (figs. 53, 54).
          f^1 Rostral at least as high as wide (fig. 63).
            g^1 Light postsuperciliary line reaches the second scale row above commissure at least two scales anterior to angle of mouth (fig. 58).
              h^1 A well-defined vertical white line on first labial and anterior nasal, occupying the posterior half of the latter (fig. 58) .. *C. adamanteus.*
              h^2 No white line on first labial and nasal, which are uniform in color and more or less dusted over with minute blackish dots.
                i^1 Predominant color grayish-brown .... *C. atrox.*
                i^2 Predominant color reddish-brown .... *C. atrox ruber.*
            g^2 Light postsuperciliary line reaches the second scale row above commissure at corner of mouth or not at all (figs. 59, 60).
              h^1 Light postsuperciliary line one scale wide; dark postocular patch starts from below anterior angle of eye (fig. 59) .... *C. confluentus.*
              h^2 Light postsuperciliary line two scales wide; dark postocular patch starts from below center of eye (fig. 60) .... *C. lucifer.*
          f^2 Rostral wider than high (fig. 61) .... *C. tigris.*
    c^2 External border of supraocular produced into a horn-like process (fig. 66) .... *C. cerastes.*
  b^2 Upper preocular divided vertically (fig. 62) .... *C. lepidus.*
a^2 Anterior nasal separated from rostral by scales (fig. 63).
  b^1 Predominant color whitish .... *C. mitchellii.*
  b^2 Predominant color red .... *C. mitchellii pyrrhus.*

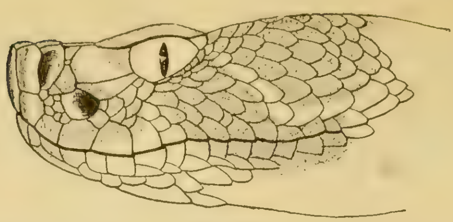

Fig. 58.
COLOR PATTERN OF SIDE OF HEAD OF CROTALUS ADAMANTEUS.

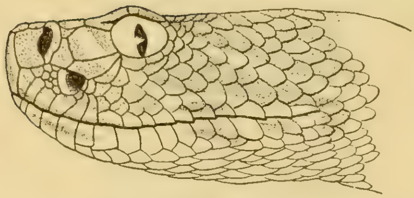

Fig. 59.
COLOR PATTERN OF SIDE OF HEAD OF CROTALUS CONFLUENTUS.

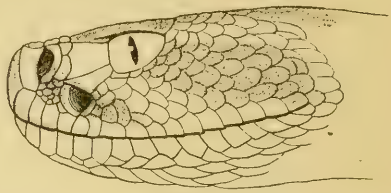

Fig. 60.
COLOR PATTERN OF SIDE OF HEAD OF CROTALUS LUCIFER.

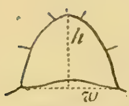

Fig. 61.
DIAGRAM OF LOW ROSTRAL.
h Height; *w* width.

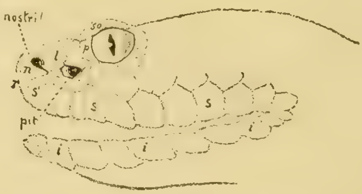

Fig. 62.
HEAD OF CROTALUS LEPIDUS FROM SIDE.
(See explanation of Fig. 55.)

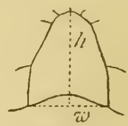

Fig. 63.
DIAGRAM OF HIGH ROSTRAL.
h Height; *w* width.

THE DOG-FACED RATTLESNAKE.

*Crotalus molossus,** Baird & Girard.

Pl. 8.

1853.—*Crotalus molossus*, BAIRD and GIRARD, N. Am. Serp., p. 10.—BAIRD, Mex. Bound. Surv., II, Rept., p. 14 (1859).—COPE, Proc. Phila. Acad., 1859, p. 338.—COPE, Bull. U. S. Nat. Mus., No. 1, p. 33 (1875).—COPE, in Wheeler's Surv. W. 100 Mer., V, p. 533 (1875).—COPE, Proc. Phila. Acad., 1883, p. 12.—COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 689 (1892).—YARROW, Bull. U. S. Nat. Mus., No. 24, pp. 12, 78 (1883).—GARMAN, Rept. Batr. N. Am., I, Ophid., p. 113, (1883).—*Caudisona molossus*, COPE, in Mitchell's Res. Ven. Rattlesn., p. 124, (1861).—COPE, Proc. Phila. Acad., 1866, pp. 307, 308.—COUES, in Wheeler's Surv. W. 100 Mer., V, p. 605 (1875).

1854.—*Crotalus ornatus*, HALLOWELL, Proc. Phila. Acad., 1854, (p. 192).—HALLOWELL, Pac. R. R. Rep., X, Parke's Route, p. 23 (1859).—COPE, Proc. Phila. Acad., 1859, p. 338.

1883.—*Crotalus durissus*, var. *molossus*, GARMAN, Rept. Batr. N. Am., I, Ophid., p. 171.

Figures.—BAIRD, Mex. Bound. Surv., II, Rept., pl. II (1859).—BAIRD, Pac. R. R. Rep., X, Rept., pl. XXIV, fig. 5.—HALLOWELL, Pac. R. R. Rep., X, pl. II (1859).

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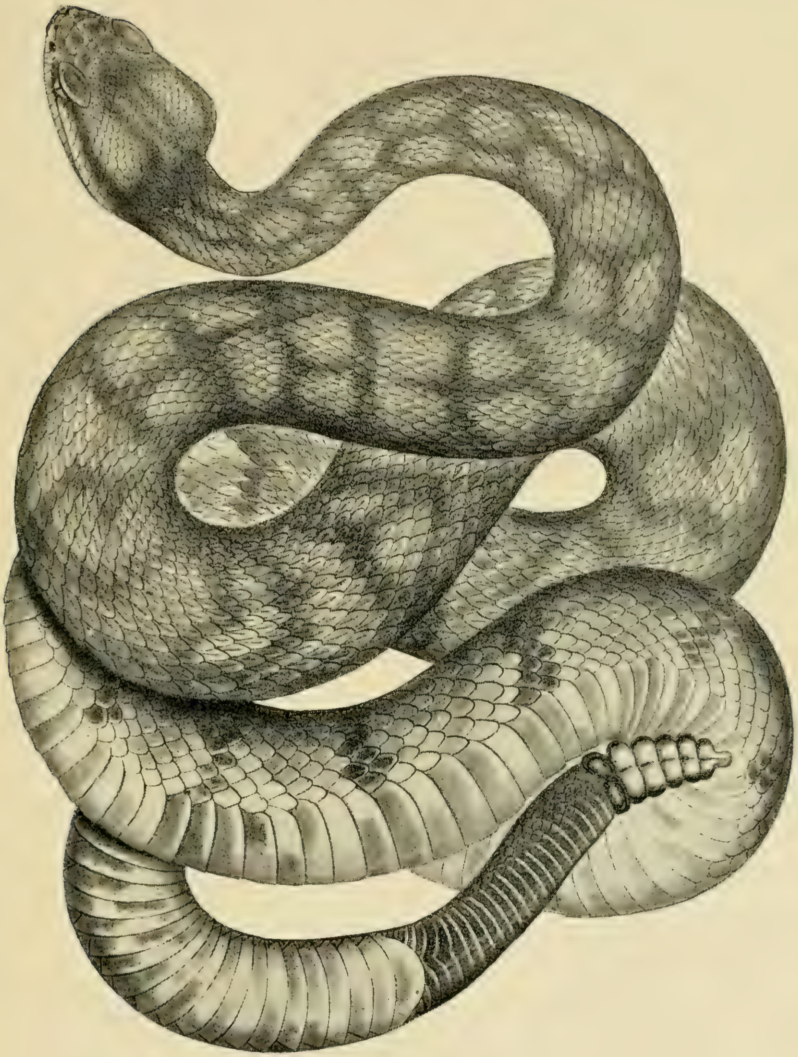
* From the Greek μολοσσός or Latin *molossus*, the Molossian wolfdog, bulldog.



DOG-FACED RATTLESNAKE,—CROTALUS MOLOSSUS.
From Hallowell, Pacific R. R. Rep.

*Description.**—Muzzle broad; rostral small. Scales between superciliaries [supraoculars] small, uniform, except the two anterior. Two frontal plates [internasals], 4 postfrontal [prefrontals], 2 intersuperciliary [interorbitals], all in contact. Five rows scales between the labials and suborbital row; middle row not extending beyond the middle of the orbit; labials, 18 above, fifth and sixth largest; 17 below. Dorsal rows of scales, 29; two external rows, small. Tail uniform black. Color roll sulphur; a series of chestnut-brown transverse lozenges [fig. 53] with exterior corners produced to the abdomen; centers of lozenges with one or two spots; each scale but one color; a brown patch below and behind the eye.

One of the most strongly marked of all species. Head very broad in front; outline nearly rectangular. Rostral small. Two anterior frontals [internasals]; behind these, four plates, the exterior resting on the superciliary; behind these two other plates, between and in contact with the superciliaries [supraorbitals]. Anterior nasal subtriangular. Top of head with numerous smooth subtuberculous scales. Suborbitals large, extending to the anterior canthus. General aspect smoother than in crotali generally; scales rounded at the posterior apex, carinated but slightly.

General color above, that of roll sulphur; beneath, pale yellowish; posteriorly, very faintly clouded with brownish. Tail black. Anteriorly the scutellæ [ventrals, or gastrosteges] are entirely immaculate. Along the back is a series of transverse reddish or chestnut-brown lozenges embraced in a width of 12 or 14 scales and 4 or 5 scales long, and with the exterior angles produced to the abdomen [fig. 53]. These lozenges are frames with the outline generally one scale in width and with the centers of the ground color; sometimes divided by a median line of brown so as to show two yellowish spots inside of the lozenges. The scales exterior to the lozenges are rather lighter. Sometimes the brown rings and the lozenges widen at the abdomen and indicate lateral spots of four scales; at others, and especially anteriorly, the rings are obsolete and the brown is in a dorsal series. In fact for the anterior fourth of the body we have a dorsal patch of brown showing alternately, at successive intervals, one large yellowish spot and then a pair of smaller ones, owing to the confluence of the successive lozenges. The superciliaries and scales anterior to them, as well as broad patch below and behind the eye, light greenish-brown. Tail uniform dark-brown above, paler beneath.

A remarkable character of this species is that each individual scale is of the same uniform tint to its base, and not showing two colors as in other species.

Variation.—The head scutellation of the present species is exceedingly variable. I have seen about nine specimens, hardly two of which

* Original description by S. F. Baird, in Baird and Girard's N. Am. Serp., p. 10, from a specimen from New Mexico, U. S. Nat. Mus., No. 485.

are alike in that respect. In all of them the snout is covered above with large shields, which sometimes extend to between the orbits, but their number and mutual relation is very variable, and often they are more or less separated by small scales. The size and shape of the rostral also varies, and the rows of scales between eye and labials vary between 4 and 6.

The coloration of this undoubtedly our most beautifully tinted crotalid is more stable. The chief variations consist in the greater or lesser degree of definition of the spots, and in the color of the tail, which in most specimens is solidly blackish though in a few it presents alternating cross bands of black and light color.

Geographical distribution.—In the main the range of *C. molossus*, at least within the borders of the United States, coincides with that of *C. lepidus*, being confined to the States and Territories bordering upon the Mexican frontier.

It was first described from a specimen collected at Santa Rita del Cobre, near the present Fort Bayard, in New Mexico, and not far from that locality it has since been taken by Prof. Cope. Henshaw procured it in southern Arizona, probably not far from Fort Buchanan, whence the Museum got a specimen from Dr. Irwin, while quite recently Dr. Thimothy E. Wilcox has sent it from Fort Huachuca. Two specimens, collected by Dr. E. Coues on San Francisco Mountain, Arizona, were identified by Cope as the present species. *C. lepidus* has not been found so far from the Mexican boundary. The range into Mexico is unknown.

The Texan specimen, upon which Hallowell based the *C. ornatus*, was collected by Dr. Heermann at the Pecos River, en route between El Paso and San Antonio, and is so far the only specimen obtained in Texas.

Habits.—Nothing is known of its habits, except that it is found among rocks.

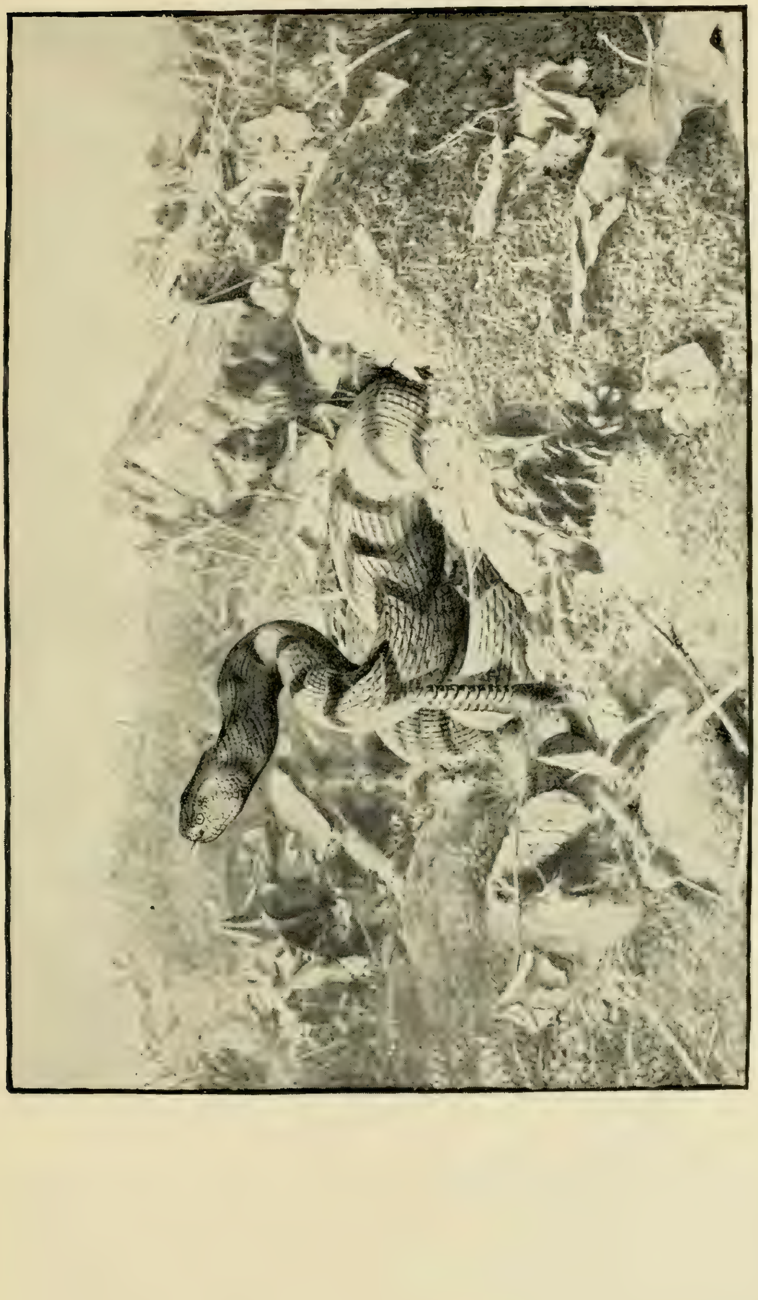
THE BANDED RATTLESNAKE.

Crotalus horridus,* Linnæus.

Plate 9.

1758.—*Crotalus horridus*, LINNÆUS, Syst. Nat., 10 ed., I, p. 214.—LINNÆUS, Syst. Nat., 12 ed., I, p. 372 (1766).—LECONTE, Proc. Phila. Acad., 1853 (p. 417).—COPE, Proc. Phila. Acad., 1859, p. 338.—COPE, Bull. U. S. Nat. Mus., No. 1, Check-list, p. 33 (1875).—COPE, in Wheeler's Surv. W. 100 Mer., V, p. 534 (1875).—COPE, Proc. U. S. Nat. Mus., XIV, 1891 (No. 382), p. 693 (1892).—YARROW, Bull. U. S. Nat. Mus., No. 24, Check List, pp. 12, 74 (1883).—CRAGIN, Trans. Kansas Acad. Sc., VII, p. 121 (1881).—GARMAN, N. Am. Rept. Batr., I, Ophid., pp. 115, 174, pl. IX, fig. 1 (1883).—GARMAN, List. N. Am. Rept. Batr., p. 35 (1884).—TRUE, in Hammond's South Carolina, p. 235 (1883).—DAVIS and RICE, Bull. Ill. State Lab. Nat. Hist., I, No. 5, 1883 (p. 27).—DAVIS and RICE, Bull. Chic. Acad. Sc., I, p. 28 (1883).—HAY, Amph. Rept. Indiana, p. 13 (1885).—HAY, Batr. Rept. Indiana, p. 128 (1893).—JORDAN, Man. Vert. North. U. S., 5

* From the Latin *horridus*, horrible, terrible.



BANDED RATTLESNAKE,—CROTALUS HORRIDUS.
From a cast in the U. S. National Museum.

ed., p. 199 (1888).—BARRINGER, Ven. Rept. U. S., p. 4 (1891).—H. GARMAN, Bull. Ill. State Lab. Nat. Hist., III, p. 311 (1892).—H. GARMAN, Bull. Ess. Inst., XXVI, 1894, p. 36.—*Crotalophorus horridus*, HOUTTUYN, Linn. Natuur. Hist., VI, p. 309 (1764).—*Caudisona horrida*, FLEMING, Philos. Zool., II, p. 294 (1822).—COPE, in Mitchell's Res. Ven. Rattlesn., p. 122 (1861).—COPE, Proc. Phila. Acad., 1866, p. 309.—COUES, Proc. Phila. Acad., 1871, p. 48.

1768.—*Caudisona durissus*, LAURENTI, Syn. Rept., p. 93 (in part only).—*Crotalus durissus*, GMELIN, Syst. Nat., I, iii, p. 1081 (in part only) (1788).—LATREILLE, Hist. Nat. Rept., III, p. 190 (1802).—DAUDIN, Hist. Nat. Rept., V, p. 304, pl. LXVIII, fig. 1, 2 (1803).—HARLAN, Journ. Phil. Acad., V, 1827, p. 368.—HARLAN, Med. Phys. Res. (p. 135) (1835).—SCHLEGEL, Ess. Phys. Serp., I, p. 192; II, p. 565 (1837).—KIRTLAND, in Mather's Sec. Rep. Geol. Surv., Ohio, pp. 167, 189 (1838).—STORER, Rep. Rept. Mass., p. 233 (1839).—HOLBROOK, N. Am. Herp., 1 ed., II, p. 81, pl. XVII (1838); 2 ed., III, p. 9, pl. I (1842).—DEKAY, Zool. N. Y., III, p. 55 (1842).—THOMPSON, Hist. Vermont, I, p. 118 (1842).—BAIRD and GIRARD, Cat. N. Am. Serp., p. 1 (1853).—LECONTE, South. Med. Surg. Journ., IX, 1853, pp. 651, 663.—BAIRD, Serp. N. York, p. 9 (1854).—BAIRD, Pac. R. R. Rep., X, Reptiles, p. 14, pl. XXIV, fig. 1 (1859).—BAIRD, Pac. R. R. Rep., X, 35th Par., Whipple's Route, p. 39 (1859).—DUMÉRIL et BIBRON, Erpét. Gén., VII, p. 1465 (1854).—KENNICOTT, Trans. Ill. State Agr. Soc., 1853–1854, I (p. 592).—JAN, Rev. Mag. Zool., 1859, Extr., p. 28.—JAN, Elenc. Sist. Ofid., p. 123 (1863).—FOGG, Sec. Ann. Rep. Nat. Hist. Geol. Maine, p. 141 (1863).—VERRILL, Proc. Boston Soc. Nat. Hist., IX, 1863, p. 197.—HOY, Smithson. Rep., 1864, p. 435.—ALLEN, Proc. Boston Soc. Nat. Hist., 1869, pp. 179, 203.—SMITH, Rep. Geol. Surv. Ohio, IV, 1882, p. 672.—HIGLEY, Trans. Wisc. Acad. Sc., VII, 1884, p. 161.

1799.—*Crotalus boiquira*, BEAUVOIS, Trans. Am. Philos. Soc., IV, p. 368, pl. fac. p. 380, low. fig.

1802.—*Crotalus atricaudatus*, LATREILLE, Hist. Nat. Rept., III, p. 209.—DAUDIN, Hist. Nat. Rept., V, p. 316 (1803).

1818.—*Crotalinus cyanurus*, RAFINESQUE, Amer. Month. Mag., III (p. 446); IV, p. 41.

1859.—? *Crotalus durissus*, var. *concolor*, JAN, Rev. Mag. Zool., 1859, Extr., p. 28.

1859.—*Crotalus durissus*, var. *melanurus*, JAN, Rev. Mag. Zool., 1859, Extr., p. 28.

1883.—*Crotalus horridus*, var. *atricaudatus*, GARMAN, Rept. Batr. N. Am., I, Ophid., pl. IX, fig. 1.

Figures: CATESBY, Carolina, II, pl. XLI (1743).—LACÉPÈDE, Quad. Ovip. Serp., II, (pl. XVIII, figs. 1, 3) (1789).—BONNATERRE, Ophiol., (pl. II, fig. 3) (1790).—SHAW, Gen. Zool., III, pl. LXXXVIII (1802).—DAUDIN, Hist. Nat. Rept., pl. LXVIII, figs. 1, 2 (1803).—GUERIN, Icon. Règne Anim., (pl. XXIII, fig. 2) (1829–'38).—SCHLEGEL, Ess. Phys. Serp., Atlas, pl. XX, figs. 15, 16 (1837).—HOLBROOK, N. Amer. Herpet., 1 ed., II, pl. XVII (1838); 2 ed., III, pl. I (1842).—DEKAY, Zool. N. York, III, pl. IX, fig. 19 (1842).—BAIRD, Serp. N. York, pl. I, fig. 1 (1854).—DUMÉRIL et BIBRON, Erpét. Gén., Atlas, pl. LXXXIV bis, fig. 1 (1854).—BAIRD, Pac. R. R. Rep., X, pl. XXIV, fig. 1 (1859).—JAN, Icon. Ophid. livr. 46, pl. I, figs. 1, 2 (1874).— GARMAN, Rept. Batr. N. Am., I, Ophid., pl. IX, fig. 1 (1883).—BREHM's Thierleben, 3 ed., VII, p. 440 (1892).

*Description.**—Head angular. Scales between the superciliaries small, numerous, uniform. Plates above snout, 2 anterior frontal [internasals] and 5 postfrontal [prefrontals]. Suborbital chain continuous, of

* By S. F. Baird, from a specimen from Huntingdon Co., Pennsylvania, U. S. Nat. Mus., No. 245. Baird & Girard, N. Am. Serp., pp. 1–2.

large scales: two rows between this and labials. Labials 12 to 14 above, fifth largest; 13 to15 below. Rows of scales on the back 23 to 25, all carinated: carination on outer row obsolete. Tail black. Above sulphur-brown, with 2 rows of confluent brown lozenges. Light line from superciliary to angle of the mouth; behind this a dark patch (figs. 64, 65).

Head above covered with small subtuberculous scales. Superciliaries (supraoculars) large. Anterior frontals (internasals) large, triangular, emarginated behind to receive a series of three small plates. A single subhexagonal plate between the superciliary (supraocular) and anterior

Fig. 64.
HEAD OF CROTALUS HORRIDUS, TOP VIEW.
(After Baird.)

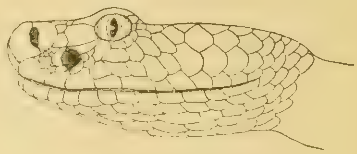


Fig. 65.
HEAD OF CROTALUS HORRIDUS, SIDE VIEW.
(After Baird.)

frontal (internasal). The exterior plate of the posterior frontal (prefrontal) row is much the largest, and is in contact with the superciliaries (supraoculars). A series of 3 or 4 large flat scales extend from the posterior extremity of the superciliary (supraocular). Scales on the cheeks (temporals) very large, truncate. Anterior orbitals (preoculars) double; the upper one rectangular, elongated longitudinally, separated from the (posterior) nasal by 2 small plates (loreals).

General color above that of roll sulphur; beneath, whitish yellow. Along the back is a double series of subrhomboidal blotches, looking as if they had been in contact, and then the line of junction partially effaced for the 3 or 4 central rows. (See fig. 52.) The impression conveyed of the color of these blotches is that of coarse mottlings of soot or gunpowder grains, more crowded exteriorly. There are 21 of these blotches from the head to the anus, the tail being entirely black. The rhomboids are inclosed within about 12 dorsal series of scales. Directly opposite to these spots on each side is a series of subtriangular blotches similarly constituted as to color, and extending from the abdomen to about the fifth lateral row, and some 6 or 7 scales long. Anteriorly these are distinct from the dorsal series, but posteriorly they are confluent with them, forming a series of zigzag blotches across the body. The scutellæ below show more or less of the grain-like mottlings. Posteriorly the yellow of the body is suffused with darker.

There are no markings of lines distinctly visible on the sides of the head. In the center of the spaces between the dorsal and lateral series of blotches are indications of small obselete spots, and in some cases

the yellow scales external to the blotches are of a lighter color than the rest.

Number of ventrals (gastrosteges), 166; of subcaudals (urosteges), 25; dorsal scale rows, 23.

Total length, 42 inches; tail, 5 inches.

Variation.—There is considerable individual variation, both in scutellation of the head and the ground color of the body.

The variation in the scutellation on top of the head is especially marked with regard to the prefrontals and the scales covering the canthus rostralis. Normally the large plates consist of 2 internasals, 2 supraoculars, and between these, on each side, a large shield, the prefrontals usually being small scales like those covering the rest of the head. In two of our specimens, however (Nos. 277 and 12748), there are a pair of large prefrontals following the internasals, while in Nos. 277 and 248 there are 2 scutes between the internasal and the supraocular on each side instead of 1.

The ground color varies greatly from light yellowish and light reddish gray through brown to almost black in some instances. In old specimens the tail is generally uniform black, but in the young ones it is banded light and black. In many specimens from localities in the Alleghany Mountains, with a moist climate, this black of the tail and sometimes even of the entire posterior half of the body is often of a deep velvety gloss.

In the majority of the Western specimens there is a broad, ill-defined, but very distinct, ochraceous band running down the center of the back. Most of them also have the postocular dark band darker and better defined than Eastern specimens; but I have been unable, with my material, to draw any line sufficiently constant.

Geographical distribution.—In former times the Banded Rattlesnake, or "Timber Rattlesnake," as it is often called in regions where other species also occur, was commonly distributed in suitable localities all over the eastern United States, except the peninsula of Florida, as far west as the subarid portion of the Great Plains, but they have now become exterminated or nearly so, in many localities, having been driven back to the wilderness by the advancing cultivation of the country.

Prof. Verrill (Proc. Boston Soc. Nat. Hist., IX, 1863, p. 197), speaking of the reptiles of Norway, Me., states that it is rare, and only found in Albany and Raymond; he had never detected it east of the Androscoggin River. In Massachusetts, according to Allen (Proc. Boston Soc. Nat. Hist., XII, 1868, p. 179), it is not unfrequent on Mount Tom, and occasionally killed on rocky hills in several of the towns near or adjoining Springfield; it also occurs at a few similar localities in the eastern part of the State.

In 1886 Prof. A. S. Packard had an article in the American Naturalist on "The Rattlesnake in New England" (Vol. XX, pp. 736–737) from which I quote the following:

We have been told that Rattlesnakes are still occasionally killed in Connecticut near the Rhode Island border. It is generally stated that the last Rattlesnake was killed in Rhode Island twenty years ago, but we are informed by Prof. Battey that one was killed at Tiverton, R. I., within a period of four years. Its skin is now in the museum of the Friends' School at Providence. Mr. Henry H. Buxton, a member of this school, from Peabody, Mass., gives us the following statement regarding its occurrence at that locality:

"In South Peabody there is a rock called Rattlesnake Rock, surrounded by woods in which there are a great many snakes, including the Rattlesnake. During the last year three or four have been killed by different persons. They confine themselves to the part of the town which is the most rocky and slightly elevated. In the winter they get under this rock and go to sleep."

Rattlesnakes are still common in the Milton Hills, near Boston, and at Hyde Park.

In confirmation of the occurrence of the Rattlesnake in Connecticut, my friend, Mr. John H. Sage, sent me two specimens in 1893 from Portland. He wrote me at the same time that quite a number are killed in this immediate vicinity (Portland) each season. As early as 1842 Thompson (Hist. Vermont, I, p. 119) says that in Vermont they have now nearly disappeared, but that formerly they were found in considerable numbers, though mostly confined to a very few localities.

In the same year De Kay speaks of the Rattlesnake in the State of New York (Zool. N. Y., III, p. 57) as follows:

The Rattlesnake is common in various parts of the State, and in the Northern States generally appears to prefer rocky situations. They abound in Clinton, Essex, and Warren counties, along the shores of Lakes Champlain and George. Some idea may be formed of their numbers in certain districts in this State by the following extract from the Clairon newspaper, published in Warren County:

"Two men, in three days, killed 1,104 Rattlesnakes on the east side of Tongue Mountain, in the town of Bolton. Some of the reptiles were very large, carrying from 15 to 20 rattles. They were killed for their oil, or grease, which is said to be very valuable."

Although numerous in the rocky, mountainous districts of this State, they are rare or entirely wanting in those elevated regions which give rise to the Moose, the Raquet, and the Hudson rivers. They are found in the counties of Sullivan, Ulster, Orange, and Greene. A few still linger in the swamps of Suffolk County.

This may be supplemented with the following statement from Prof. Baird's "Serpents of New York," p. 10 (1854):

In New York it seems to be most abundant on the shores of Lake George and Lake Champlain; especially in Rattlesnake Mountain of the former and Rattlesnake den of the latter, a rocky bluff between Westport and Essex. It is a little remarkable that the rattlesnake does not occur in the Adirondack regions of New York; at least, an instance has never come to my knowledge. Such a region in Pennsylvania would be infested by them.

As indicated in the last sentence it is still fairly common in the Alleghany Mountains, from Pennsylvania southwards, though by no means confined to the high altitude, as we have specimens from Wilmington, in North Carolina, Liberty County and Saint Simons Isle, Georgia, while Dr. E. Coues quotes it as common in the vicinity of Fort Macon, North Carolina, and certainly occurring on the islands as well.

The Banded Rattlesnake probably does not enter the Florida peninsula proper, but the National Museum is indebted to Judge Bell for a fine specimen from Gainesville, in the interior, at the base of the peninsula. It occurs also in all the other Southern States, and I have even seen a specimen from Houma, in the pine lands southwest of New Orleans.

In the mountains of Tennessee and Kentucky the Banded Rattlesnake is still fairly common, but not so in Ohio and Indiana. Kirtland, as early as 1838 (in Mather's Sec. Rep. Geol. Surv. Ohio, p. 167), stated that in the former State it was then but rarely seen, though formerly very abundant, and with regard to Indiana we have Dr. O. P. Hay's recent assertion (Batr. Rept. Indiana, 1893, p. 129) that it is to be found, in all probability, in nearly all the counties of Indiana, though in most places quite rare. He can only name two localities where it has been taken recently and record of it preserved, viz, New Harmony and Monroe County. In Michigan it appears to be rare, the only definite record I can lay hand on at present being that of Dr. Morris Gibbs (Wolverine Naturalist, February, 1890, p. 12) of a specimen killed in Kalamazoo County.

H. Garman (Bull. Ill. State Lab. Nat. Hist., III, 1892, p. 312) is authority for the statement that it occurs throughout Illinois in hilly, forest regions, though being rapidly exterminated, while Higley (Trans. Wis. Acad. Sc., VII, 1884, p. 161), in regard to its distribution in Wisconsin, has only this to say, that it was formerly very common, but is now seldom met, and that it may be found in the rocky bluffs of the larger rivers.

Mr. Julius Hurter (Trans. St. Louis Acad. Sc., VI, Dec. 1893, p. 258) has an interesting note on a local increase of this snake. Years ago, he says, it was rather scarce in St. Clair County, Ill., as in those days there was no stock law, and the pigs roamed around and exterminated a good many snakes, but since the stock law has gone into effect, compelling swine to be penned up, the snakes have become more numerous again. In early spring they are found near the bluffs under rocks, but later on they go to the wheat fields and meadows, where they are very safe till harvest time, when a good many are destroyed by the farm hands.

West of the Mississippi they are still found in eastern Iowa, at least, Kansas, Missouri, Arkansas, and Indian Territory. The Banded Rattlesnake even extends into Texas, as Dr. Shumard sent to the Smithsonian Institution a specimen collected on the upper Brazos during Capt. Marcy's exploration of that river.

Habits.—In a general way most of what has been written about the habits of the rattlesnake refers to the present species. In contradistinction to the Water Rattlesnake, *C. adamanteus*, and the Prairie Rattlesnake, *C. confluentus*, the present species is often called the "Timber Rattler," because of its predilection for wooded districts. It does undoubtedly often in summer take up its abode in prairies and mead-

ows, but it prefers rocky and mountainous places, where it can find holes and crevices to hide itself, or sunny ledges, where it may enjoy the heat of the day.

It has been repeatedly denied that the Rattlesnake climbs trees, and it is certain enough that it does not do so habitually. It is but ill fitted for climbing, yet there are unquestionable proofs that they do so occasionally. Of course, they do not climb up tall, smooth, perpendicular trunks, but it is not more difficult for it to climb up a rough-barked slanting tree with plenty of side branches than to wriggle up the rocks of a mountain side.

The food of the Banded Rattlesnake consists in all sort of smaller warm-blooded animals which may come its way, as rabbits, squirrels, rats, mice, and an occasional bird. Holbrook pictures this species as remarkably slow and sluggish, lying quietly in wait for his prey, and never wantonly attacking nor destroying animals, except as food, unless disturbed by them. A single touch, however, will effect this; even rattling the leaves in his neighborhood is sufficient to irritate him. On such occasions he immediately coils himself, shakes his rattles violently in sign of rage, and strikes at whatever is placed within his reach. In his native woods, Holbrook continues, one may pass within a few feet of him unmolested. Though aware of the passenger's presence, he either lies quiet or glides away to a more retired spot. He never follows the object of his rage, whether an animal that has unwarily approached so near as to touch him, or only a stick thrust at him to provoke his anger, but strikes on the spot, and prepares to repeat the blow, or he may slowly retreat like an unconquered enemy, sure of his strength, but not choosing further combat.

Compared with the Diamond-backed Rattlesnake, the Banded Rattler is the more timid and less aggressive. Speaking of these animals one does not quite feel like characterizing any of them as "gentle," yet this is an expression used by many a one who has had plenty of experience with them. The late Gen. Kirby Smith once told me of an incident which illustrates the amount of provocation a Rattlesnake will pass unnoticed under certain circumstances. Gen. Smith's home in Tennessee was located on a high plateau, and a narrow path led from the house to the small railway station in the valley below. One day a party of ladies went down the path in Indian file, the general in the lead, and the rear being brought up by a barefooted lad carrying a valise. Suddenly the latter shouted. A Rattlesnake was lying coiled in the path, and he had just discovered it in stepping over it without touching it. By the merest chance they had all avoided stepping upon it, though it seemed almost impossible that the ladies' dresses should not have touched it. Gen. Smith said he felt like sparing the snake's life. In captivity a Banded Rattlesnake may be handled with impunity by a self-possessed man, if he moves quietly and deliberately, not frightening it by any sudden and unexpected movements. There even seems to be truth in some of the stories about children having been

found playing with and carrying about live Rattlesnakes without having been hurt.*

It is somewhat curious that the breeding habits of this species are still almost unknown. At least, very little definite information is on record. The time of pairing is difficult to ascertain. The number of young born at one birth appears to be about nine. The largest of a number of embryos preserved by Prof. S. F. Baird (U. S. Nat. Mus., No. 1292) and apparently ready to be born is about 245 mm. (9½ inches) long, with a diameter of 12 mm. (one-half inch).

THE DIAMOND RATTLESNAKE.

Crotalus adamanteus, Beauvois.

Plate 10.

1799.—*Crolatus adamanteus*, † BEAUVOIS, Trans. Am. Philos. Soc. IV, p. 368.—SAY, Sillim. Am. Journ. Sc., I, 1819, p. 263.—HOLBROOK, N. Am. Herpet., 1 ed., II, p. 77 (1838).—HOLBROOK, N. Am. Herpet., 2 ed., III, p. 17 (1842).—DE KAY, Zool. New York, III, p. 57 (1842).—BAIRD and GIRARD, Cat. N. Am. Serp., p. 3 (1853).—LE CONTE, South. Med. Surg. Journ., IX, 1853 (p. 664).—BAIRD, Pac. R. R. Rep., X, Reptiles, p. 14, pl. XXIV, fig. 2 (1859).—JAN, Rev. Mag. Zool., 1859, extr. p. 28.—JAN, Elenc. Sist. Ofid., p. 123 (1863).—COPE, in Wheeler's Surv. W. 100 Mer., V, p. 534 (1875).—COPE, Proc. Am. Philos. Soc., 1867 (p. 64).—COPE, Proc. U. S. Nat. Mus. XIV, 1891, p. 689 (1892).—TRUE, in Hammond's South Carolina, p. 235 (1883).—GARMAN, Rept. Batr. N. Am., I, Ophid., pp. 112, 171 (1883).—GARMAN, Bull. Essex. Inst., XIX, 1887, p. 122.—YARROW, in Buck's Ref. Handb. Med. Sc., VI, p. 166 (1888).—JORDAN, Man. Vert. North. U. S., 5 ed., p. 199 (1888).—BARRINGER, Ven. Rept. U. S., p. 4 (1891).—WILLIAMS, Science, XX, Dec. 16, 1892, p. 345.—LŒNNBERG, Proc. U. S. Nat. Mus., XVII, 1894, p. 335.—H. GARMAN, Bull. Essex. Inst., XXVI, 1894, p. 36.—*Caudisona adamantea*, COPE, in Mitchell's Res. Ven, Rattlesn., p. 121 (1861).—COPE, Proc. Phila. Acad., 1866, p. 309.

1802.—*Crotalus rhombifer*, LATREILLE, Hist. Nat. Rept., III, p. 197.—DAUDIN, Hist. Nat, Rept., V, p. 323 (1803).—DUMÉRIL et BIBRON, Erpét. Génér., VII, p. 1470 (1854).—DUGÈS, Naturaleza, IV, 1879 (p. 22).

1802.—*Crotalus horridus*, LATREILLE, Hist. Nat. Rept., III, p. 199 (but not p. 186; nor of Linn. 1758).—HARLAN, Journ. Phila. Acad., V, 1827, p. 370.—HARLAN, Med. Phys. Res. (p.133) (1835).

1802.—*Crotalus durissus*, SHAW, Gen. Zoöl., III, p. 333 (not of Linn. 1758).

1853.—*Crotalus terrificus*, LE CONTE, Proc. Phila. Acad., 1853 (p. 419) (not of Laur. 1768).—COPE, Proc. Phila. Acad., 1859, p. 337.

1875.—*Crotalus adamanteus*, subsp. *adamanteus*, COPE, Bull. U. S. Nat. Mus. No. 1, Check-list, pp. 33, 79.—COPE, Proc. U. S. Nat. Mus., XI, 1888, p. 393.—COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 690 (1892).—YARROW, Bull. U. S. Nat. Mus. No. 24, pp. 12, 75 (1883).

Figures.—BEAUVOIS, Trans. Am. Philos. Soc., IV, pl. facing p. 380, upper figure (1799).—SHAW, Gen. Zool., III, pl. LXXXIX (1802).—DAUDIN, Hist. Nat. Rept. V pl. LX, figs. 22, 23; pl. LXIX, fig. 2 (1803).—HOLBROOK, N. Am. Herpet., 1 ed., II, pl. XVI (1838); 2 ed., III, pl. II (1842).—DUMÉRIL et BIBRON, Erpét. Gen., Atlas, pl. LXXXIV, fig. 3 (1854).—BAIRD, Pac. R. R. Rep., X, Reptiles, pl. XXIV, fig. 2 (1859).—JAN, Icon. Ophid., livr. 46, pl. II, fig. 2 (but not fig. 1) (1874).—YARROW, in Buck's Ref. Handb. Med. Sc., VI, pl. XXVII (1888).

* See Forest and Stream, XXXVII, Aug. 6, 1891, p. 44.

† From the Latin *adamanteus*, Diamond-shaped; lozenge-shaped.

*Description.**—Head triangular. Two anterior frontals (internasals), connected with superciliaries (supraoculars) on each side by two large plates; inside of these a second row; included space filled by small scales. Scales margining superciliaries (supraoculars) small; scattered larger ones toward the center of the intermediate space. Three rows of scales between the suborbitals and labials. Suborbitals extending to the middle of the orbit. Labials 15 or 16 above; first, fifth, and seventh largest, and vertical; below, 18; first, fourth, and fifth largest. Dorsal rows, 27; outer rows obsoletely carinated. Three or 4 dark rings on tail. Three series of well-defined perfect rhombs, 1 dorsal, 2 lateral, separated by narrow lines. Light stripe from superciliary to the angle of the mouth.

Scales on the cheek smooth. Three rather large plates on the edge of the upper part of the head, between the superciliaries (supraoculars) and rostral, inside of which is a second row of 3, also larger than the rest.

The two lower rows of lateral scales smooth. Third and fourth very faintly carinated. Scales on the back and sides not conspicuously different in size except the lower two or three rows. Posteriorly, near the tail, all the scales are carinated except the lowest.

General color, yellowish gray, with rhomboidal black blotches, lighter in the center, and with all the angles perfect. Or rather there is a series of dull yellowish lines crossing obliquely from one side of the abdomen to the other over the back, following the oblique series of scales, and occupying generally the posterior half of each scale, the basal portion being black. These lines, of which there are about 36 crossing from each side, from head to tail (9 on tail), decussate first on the fifth or sixth lateral row, and then on the back, where they are more or less confluent three or four rows. The rhomboids thus inclosed and crossing the back are generally black for 1½ or 2 scales within the yellowish brown, mottled with darker. The intervals on the sides between the lines are mostly dark yellowish brown, minutely mottled with dark brown. These intervals constitute a lateral series of transverse rhomboids, sometimes with the lower angle truncated. Opposite to the dorsal rhomboids is a series of small triangles in the angles of the first decussation. The distance between two parallel transverse stripes generally consists of five rows of scales, occasionally of six.

On the sides and posteriorly these markings are more or less indistinct, though generally recognizable. The tail usually exhibits a good deal of black. The under parts are dull yellowish white, or greenish white, clouded toward the sides with brown; no regular spots visible. The black on the tail does not constitute complete rings, but is interrupted in the middle of the lower surface, and in fact the black patches alternate with each other, and are not opposite.

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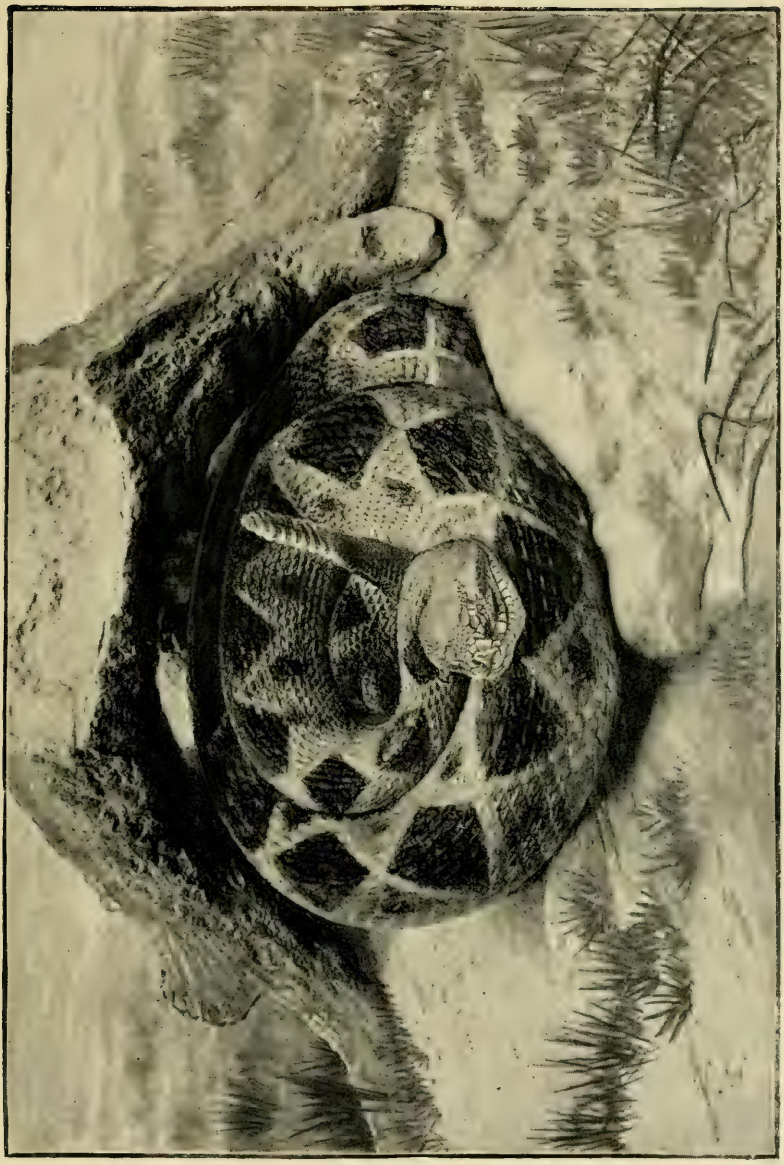
* By S. F. Baird, in Baird and Girard's, N. Am. Serp., p. 3, from a South Carolina specimen, U. S. Nat. Mus., No. 250.



DIAMOND RATTLESNAKE.--CROTALUS ADAMANTEUS.

From a cast in the U. S. National Museum.

The top of head is light brown, with occasional black scales. A dull yellowish streak starts at the posterior edge of the superciliary plate, and passing obliquely backward, through two rows of scales, extends to angle of the mouth (fig. 58). A second band starts on the plate in advance of the superciliary, and crossing the anterior orbitals, expands till it involves the seventh, eighth, and ninth upper labials. Interval between the first two stripes dark brown. There are also indications of a second vertical light bar in front of the nostril, and two below the pit. Rostral dark yellowish, lighter in the margin.

Number of ventrals (gastrosteges), 169; of subcaudals (urosteges), 32; scale rows across body, 27.

Variation.—With the exception of the usual variation of the ground color through the various tinges of grayish and brownish, the color and pattern of this species is unusually constant. The characteristic whitish stripes on rostral, nasals, and on the sides of the head are well marked, even in the largest specimens, and the dorsal pattern is also nearly always very distinct.

Geographical distribution.—The diamond rattler inhabits a comparatively small area in the southeastern corner of our country. Florida seems to be the center of its distribution, and from that State it extends along the coast northward into the southern portion of North Carolina at about the thirty-fifth parallel, Mr. H. H. Brimley having in letter advised me of a specimen, presumably of this species, having been taken in 1885 at the Neuse River, across from New Berne. Along the gulf coast it extends at least as far west as the Mississippi River, being still found not far from New Orleans, as Dr. Gustave Kohn informs me, although very scarce. It also ascends the Mississippi River some distance, exactly how far I do not know, but a specimen is in the National Museum (No. 4393) which is said to have been collected by Col. Kearney in Arkansas.

In Florida the species is found everywhere, including the Keys.

Habits.—The Diamond Rattler, or Diamond-backed Rattlesnake, is usually called the Water Rattler in localities where the Banded Rattlesnake also occurs in order to distinguish it from the latter, which is then known as the Timber-Rattler. As the name indicates, this species is rather partial to the neighborhood of water, although it is not a water snake to the extent of pursuing its prey into the water. Yet it is said to be a good swimmer and not even afraid to cross over from Key to Key (*Lœnnberg, l. c.*).

Although rather common, and probably the Rattlesnake most frequently seen in captivity, at least in this country, but little detailed and reliable information concerning its habits can be found in the literature. The observers who have had anything to say about it are often much at variance. Some regard it as very slow and clumsy, others again insist that it is much more active than the Banded Rattlesnake and much fiercer. Some report their inability to induce this species

to eat in confinement, while others again claim that it takes food without trouble. Equally defective is our knowledge in regard to its breeding habits.

The Diamond Rattler is our largest species, and in fact one of the largest of the whole family. The largest specimen in the National Museum collection (No. 10947) is only 6 feet 5¼ inches long, but much larger specimens are on record. Dr. C. S. Allen has recorded 1 specimen 8 feet 5 inches, with a circumference of 15 inches, which was shot near Oak Lodge, Fla., by Chas. F. Latham, in November, 1890, while Mr. Frank M. Chapman mentions one 8 feet 9 inches long, and killed by J. H. Norton, of Jacksonville.*

We often enough hear of Florida Rattlers 9 feet or more long, but in all cases I have investigated it was found that the measurements were taken from skins, or mounted specimens, which of course may be stretched almost to any desired length.

With a supply of venom proportionate to its size the dangerous nature of a stroke of one of these large brutes, if well delivered, may well be imagined. Nevertheless, fatalities are comparatively rare, and even cases of bites are not heard of nearly as often as one might be led to suppose from the number of specimens which are still found in many places.

THE TEXAS RATTLESNAKE.

Crotalus atrox,† Baird and Girard.

Plate 11.

1853.—*Crotalus atrox*, BAIRD and GIRARD, N. Am. Serp., pp. 5, 156.—DUMÉRIL et BIBRON, Erpét, Génér., VII, ii, p. 1482 (1854).—HALLOWELL, Proc. Phila. Acad., 1856, p. 307.—BAIRD, Pac. R. R. Rep., X, Whipple's Route, p. 39 (1859).—BAIRD, Mex. Bound. Surv. II, Rept. p. 14 (1859).—COPE, Proc. Phila. Acad., 1859, p. 337.—COPE, in Wheeler's Surv. W. 100 Mer., V, p. 534 (1875).—COOPER, Proc. Calif. Acad. Nat. Sc., IV, p. 66 (1870).—*Caudisona atrox*, COPE, in Mitchell's Res. Ven. Rattlesn. (p. 121) (1861).—COPE, Proc. Phila. Acad. 1866, p. 309.

1859.—*Crotalus adamanteus*, var. *atrox*, JAN, Rev. Mag. Zool., 1859, Extr. p. 28.—JAN, Elenc. Sist. Ofid., p. 123 (1863).—COPE, Bull. U. S. Nat. Mus. No. 1, p. 33 (1875).—COPE, Bull. U. S. Nat. Mus. No. 17, p. 24 (1880).—COPE, Proc. U. S. Nat. Mus., XI, 1888, p. 398.—COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 690 (1892).—COPE, Proc. Phila. Acad., 1892, p. 336.—YARROW, Bull. U. S. Nat. Mus. No. 24, pp. 12, 76 (1883).—GARMAN, Rept. Batr. N. Am., I, Ophid., pp. 113, 172 (1883).—*Caudisona adamantea atrox*, COUES, in Wheeler's Surv. W. 100 Mer., V, p. 607 (1875).

1861.—*Caudisona atrox*, var. *sonoraensis*, KENNICOTT, Proc. Phila. Acad., XIII, 1861, p. 206.—COPE, Proc. Phila. Acad., XIII, 1861, p. 292.

1861.—*Caudisona scutulata*, KENNICOTT, Proc. Phila. Acad., XIII, 1861, p. 207.—COPE, Proc. Phila. Acad., 1866, p. 309.—*Crotalus scutulatus* COPE, in Wheeler's Surv. W. 100 Mer., V, p. 533 (1875).

1863.—*Crotalus adamanteus*, var. *sonoriensis*, JAN, Elenc. Sist. Ofid., p. 124.

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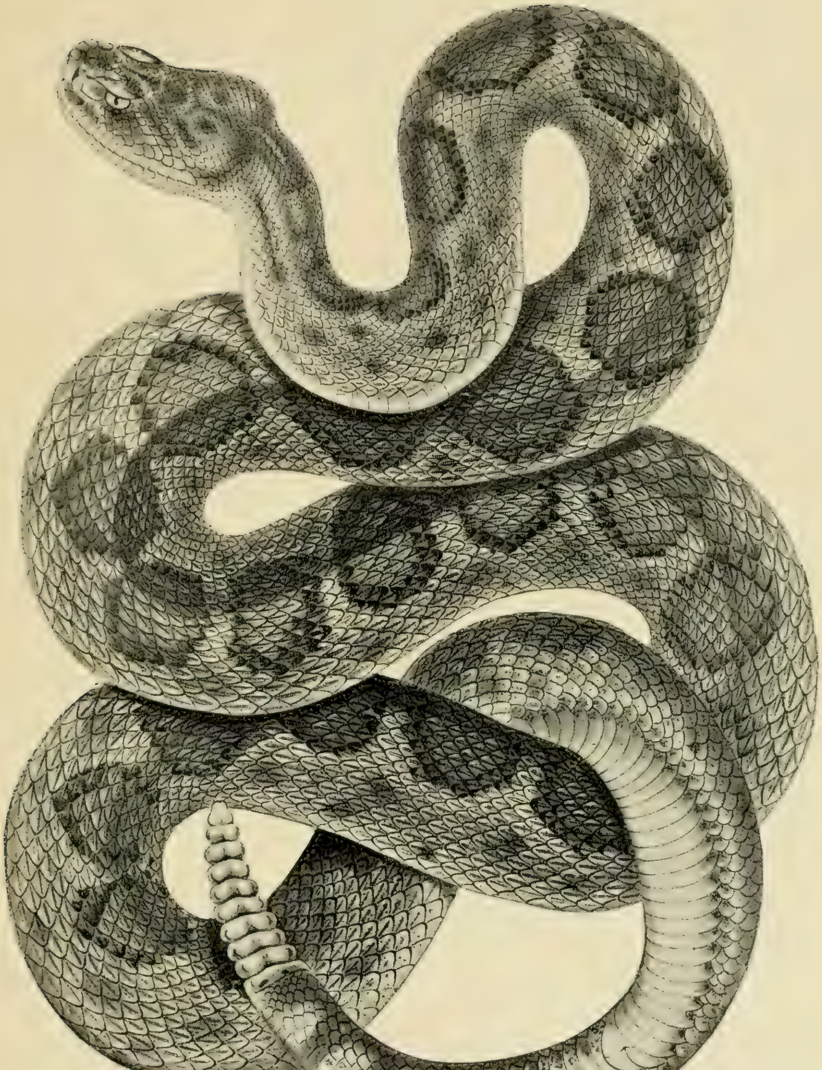
* Abstr. Proc. Linn. Soc. New York, year end. Mch. 2, 1892, p. 4.

† From the Latin *atrox*, terrible, cruel.



TEXAS RATTLESNAKE,—CROTALUS ATROX.
From Baird, Rep. Mex. Bound. Surv.

1874.—*Crotalus adamanteus*, JAN, Icon. Ophid., livr. 46, pl. II, fig. 1 (not of Beauvois).

1875.—*Crotalus adamanteus*, var. *scutulatus*, COPE, Bull. U. S. Nat. Mus., No. 1, p. 33.—COPE, Proc. U. S. Nat. Mus. XIV, 1891, p. 690 (1892).—*Caudisona adamantea scutulata*, COUES, in Wheeler's Surv. W. 100 Mer., V, p. 607.

Figures.—BAIRD, Mex. Bound. Surv., II, Rept., pl. I (1859).—BAIRD, Pac. R. R. Rep., X, Rept., pl. XXIV, fig. 3 (1859).—JAN, Icon. Ophid., livr. 46, pl. II, fig. 1 (1874).

*Description.**—Head subtriangular; plates on head; 2 anterior frontals (internasals) in contact; between these and superciliaries (supraoculars), on side of the crown, 2 imbricated plates; space inclosed occupied by smaller scales; superciliaries (supraoculars) bordered by a row of larger scales; the anterior much largest. Three rows of scales between labials and suborbitals; labials 16 above, first, fifth, and seventh, largest; 15 below, first and third largest; dorsal rows 25–27; 2 exterior rows smooth; on the tail 3–6 half rings. Color yellowish brown, with a continuous succession of dorsal lozenges, sometimes truncate before and behind; intervals all narrow. A single transverse light line; superciliary stripe from superciliary directly to the angle of the mouth.

General style of coloration somewhat as in *C. adamanteus*. Ground color above, dull yellowish brown, with a series of subhexagonal patches from the head nearly to the tail, in an uninterrupted series, separated throughout by narrow lines. We may refer the markings to the intersection of two series of light yellowish lines, about 40 in number, crossing obliquely from each side across to the other, along the anterior half of as many oblique series of scales. The lateral decussation is along the sixth row of dorsal scales; on the back, where they cross, the lines are confluent for a breadth of 5 or 6 scales, making a series of transverse lines across the back, truncating the obtuse angles of the rhomboids, which would otherwise be produced. Sometimes the acute lateral angles of the rhomboids are also truncated. Laterally, the yellowish lines are more or less obsolete, leaving a more or less distinct chain pattern. The rhomboids or subrhomboids inclosed have a narrow margin of dark brown, lighter toward the center. In all cases the interval between the successive rhomboids is but 1 or 2 half scales in width. The lateral rhomboids and triangles referred to in *C. adamanteus* are indicated by two alternating series of dark brown blotches, the first along the third and fourth lateral row, opposite the apices of the rhomboids; the second along the sixth and seventh, and alternating with the same; the spots occupy 1 scale, or part of 4 contiguous ones. Space between these rhomboids and the yellowish lines, dull yellowish brown. Beneath nearly uniform yellowish, slightly clouded on the sides of the scales. On the tail the blotches are confluent into 3 or 6 dark brown half rings, interrupted on the surface. General distribution of lines on the head much as in

* Original description by S. F. Baird, in Baird and Girard, N. Am. Serp., p. 5, from the type specimens from Texas.

C. adamanteus; a narrow light line from the posterior end of superciliary backward directly to the angle of the mouth; a second from the anterior extremity, nearly parallel with the first, the two inclosing an indistinct patch and separated on the labials by 4½ scales. There is also a single narrow light line across the superciliary perpendicular to its length, obsolete in old specimens.

It may readily be distinguished from *C. adamanteus* by its light color and the truncations of the rhomboids, as well as the general obsoleteness of the lateral markings. The rhomboids are longer in proportion and more rounded. The 2 lateral rows of scales are smooth, the next 2 more strongly carinated than in *C. adamanteus.* The fifth upper labial is largest, and transverse, the rest nearly uniform. The stripes on the side of the head are less distinct.

From *C. confluentus* it may be distinguished by the greater comparative size of the interval between the dorsal blotches, especially posteriorly. In *C. confluentus* there are two light lines across the superciliary plate, dividing it into three sections, the central rather narrower.

Here, too, the posterior facial stripe, instead of passing to the angle of the mouth, goes back of it on the second row above the labials, in *C. atrox*, passing directly to the angle of the mouth. Other important distinctions are seen in the narrower scales of *C. confluentus*, etc.

From *C. lucifer*, the more narrow head, fewer and larger intersuperciliary scales, lighter color, arrangement of color along the head, will at once distinguish it.

Number of ventrals (gastrosteges), 177 to 187; number of subcaudals (urosteges), 23 to 28; number of scale rows across the body, 25 to 27.

Variation.—This species exhibits a considerable variation in the scutellation, less so in coloration. The ground color is usually more or less grayish, with a varying amount of brownish, olive, or yellowish admixture, while on the Pacific coast there seems to be a reddish form, geographically limited, which will be considered separately as a race. The head pattern is fairly constant and will at once serve to distinguish this species from *C. adamanteus*, the nasals and anterior labials being unicolor, densely dusted over with minute black dots.

As for the scutellation, the greatest variation is shown in the presence, or absence, of an upper loreal, as well as in the size of the scales or scutes covering the upper surface of the snout. In a number of specimens the upper head scales are more or less enlarged, in some forming on the snout a series of paired scutes reaching to between the orbits, very much after fashion of *C. molossus* and its nearest allies. This character, however, is shared by specimens belonging to other species, for instance *C. horridus*, and notably in *C. confluentus*, so much so, in fact, that the so-called *C. scutulatus*, which is based upon such specimens, is composed of specimens of both species. The character is mostly exhibited in specimens from the Mexican tableland and its extension into Arizona, but it is apparently not constant enough to

warrant us in recognizing it as a geographic subspecies even. The character is an ancestral one, and its appearance may probably be attributed to reversion.

Geographical distribution.—*Crotalus atrox* covers a considerable area, embracing the arid portion of Texas, parts of southern New Mexico, Arizona, and California, southward into Mexico. In western and southern Texas, west of about the ninety-seventh meridian this species appear to be *the* Rattlesnake, being apparently common in all suitable localities. It does not appear to occur in the moist region of eastern Texas, and as a matter of fact we do not know which form occupies that region at all, whether *C. adamanteus* extends so far west as to meet its western representative, *C. atrox*, or whether there is an actual gap between the two species, occupied by neither. Toward the north, Prof. Cope (Proc. Phila. Acad., 1892, p. 336), has found it at the eastern foot of the Staked Plain, about the head of the Colorado River, but he did not meet with it on the Plain itself, nor north of the region mentioned. That it extends considerably farther north is proven, however, by a specimen (No. 4225) in the National Museum, collected near the western boundary of Texas, just south of the Canadian River and at the northern foot of the Llano Estacado.

Habits.—Very little has been written concerning the habits of *C. atrox*, but in a general way they may be considered to be similar to those of *C. adamanteus*, except that the former is apparently less partial to water. Being a large and powerful snake, though not quite so large as the Diamond Rattlesnake, it is capable of inflicting very dangerous bites.

The Red Diamond Rattlesnake.

Crotalus atrox ruber,* Cope.

1892.—*Crotalus adamanteus ruber*, Cope, Proc. U. S. Nat. Mus., xiv, 1891, p. 690.

Description.†—Rostral plate a little wider than high; plates of upper side of canthers rostralis smaller than in other subspecies, the posterior especially smaller than the anterior, and partly decurved laterally. One loreal. Five rows of scales between orbit and labial; eight rows between superciliary plates. Second pair of inferior labials with the marginal portion cut off from the postsymphyseal portion. (Perhaps an abnormality.)

The color is light red, marked above with deep red spots. These are of a longitudinal oval form anteriorly, but posteriorly they have a diamond-shaped form. They have no distinct lateral borders, either light or dark, but they are separated on the median line of the back by a single row of yellow-tipped scales. Traces of brownish red indefinite

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* From the Latin *ruber*, red, ruddy.

† Original description by E. D. Cope, in Proc. U. S. Nat. Mus., xiv, 1891, p. 690, from U. S. Nat. Mus., No. 9209; locality unknown.

spots opposite their lateral angles as well as their intervals. Head without marking, except a faint trace of a pale line from the eye to the border of the mouth below it. Inferior surfaces yellow. Tail white, with five black cross bands, of which all but the first are complete rings.

Gastrosteges (ventrals), 186; urosteges (subcaudals), 26; scale rows, 27; total length, 1.245 mm.

Variation.—The characters upon which this form were originally based, viz, the small size of the scales on canthus rostralis and the absence of either light or dark borders to the dorsal rhombs do not seem to hold in a larger series, for of the additional specimens which I have seen some have the canthal scales of normal size, while in nearly all the specimens there are traces at least of the borders to the dorsal spots, these borders becoming apparently less distinct as the snakes grow larger. The only character which seems to fairly distinguish this form as a subspecies is the bright cinnamon red color of its upper surface, at least in the large specimens.

Geographical distribution.—This subspecies was originally described from a specimen the habitat of which was not known. Since then I have seen, thanks to Dr. C. Hart Merriam, several large specimens from Twin Oaks, San Diego County, on the Pacific slope of the coast ranges, which fixes the range of the form. A young specimen in the National Museum (No. 8856), somewhat darker and less bright red than the others, probably either on account of its age or the long time it has been in alcohol, is recorded as collected by A. W. Chase at San Francisco, November, 1875, but it is probably very doubtful if the specimen really came from the immediate vicinity of that city.

Habits.—Nothing special is known of the life history of this form.

THE PRAIRIE RATTLESNAKE.

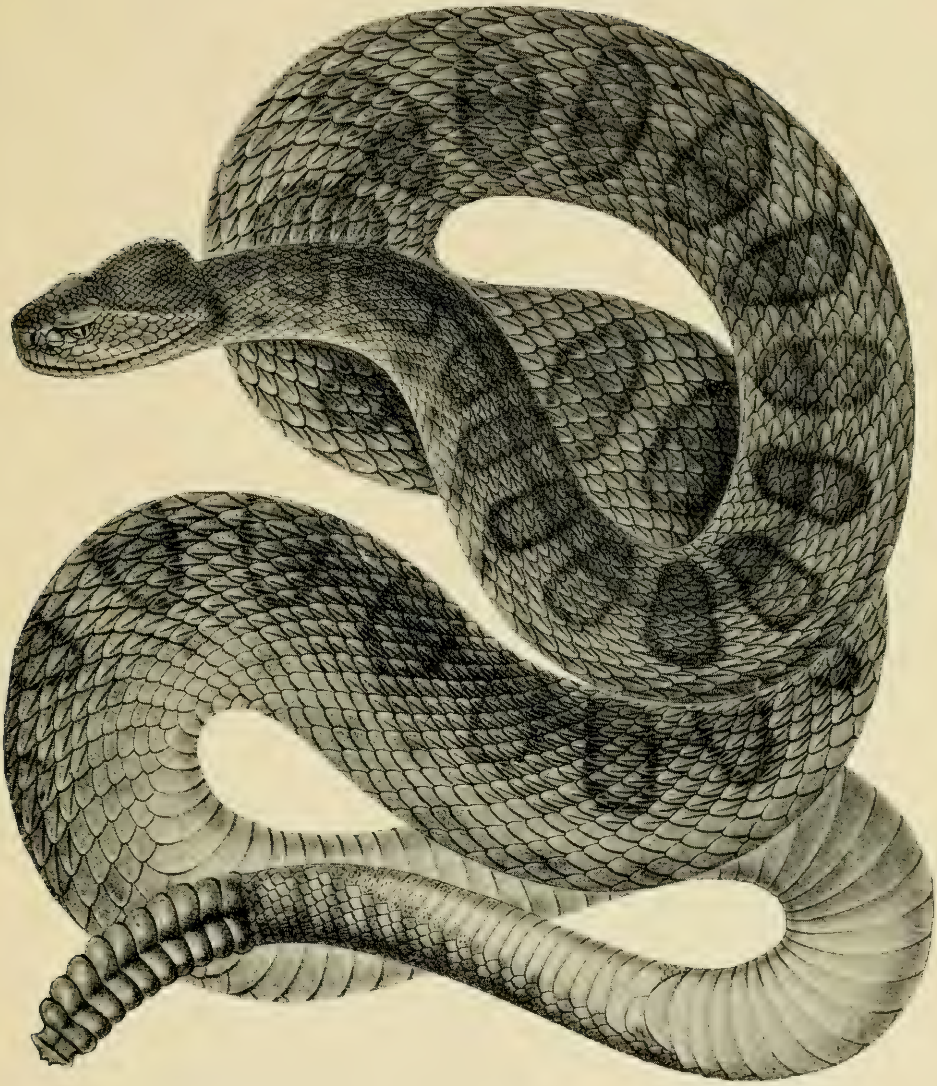
Crotalus confluentus,* Say.

Plate 12.

1818.—?*Crotalinus viridis*, RAFINESQUE, Am. Month. Mag., IV, 1818, p. 41.

1823.—*Crotalus confluentus*, SAY, in Long's Exped. Rocky Mts., II, p. 48.—BAIRD and GIRARD, N. Am. Serp., p. 8 (1853).—BAIRD and GIRARD, in Marcy's Expl. Red River, p. 214, Zool., pl. I (1853).—HALLOWELL, Proc. Phila. Acad., 1856, p. 250.—BAIRD, Pac. R. R. Rep., X, Whipple's Route, p. 40 (1859).—BAIRD, Mex. Bound. Surv., II, Rept., p. 14 (1859).—COOPER, Pac. R. R., Rep., XII, pt. III, p. 295 (1860).—COOPER, Amer. Natural, 1869, p. 124.—COPE, Proc. Phil. Acad., 1859, p. 337 (1860).—COPE, Bull. U. S. Nat. Mus., No. 1, p. 33 (1875).—COPE, Amer. Natural., XIII, 1879, p. 435.—COPE, Bull. U. S. Nat. Mus., No. 17, p. 24 (1880).—YARROW, in Wheeler's Surv. W. 100 Mer., V, p. 530 (part) (1875).—COUES and YARROW, Bull. Geol. Surv. Terr. (Hayden's), IV, No. 1, Feb., 1878, p. 262.—CRAGIN, Trans. Kansas Acad. Sc., VII, p. 121 (1881).—GARMAN, Rept. Batr. N. Am. Ophid., pp. 114, 172 (1883).—GARMAN, List N. Am. Rept. Batr., p. 34 (1884).—STEJNEGER,

* From the Latin *confluens*, flowing together; with reference to the spots on the neck of the type specimen running together into a longitudinal mark.



PRAIRIE RATTLESNAKE,—CROTALUS CONFLUENTUS.

From Baird, Pacific R. R. Rep

N. Amer. Fauna, No. 5, p. 111 (1891).—TAYLOR, Ann. Rep. Nebraska State Board Agric., 1891, p. 354 (1892).—HAY, Proc. U. S. Nat. Mus., XV, 1892, p. 387.—COUES, Hist. Exp. Lewis and Clark, I, p. 313; II, p. 373 (1893).—*Caudisona confluenta* COPE, in Mitchell's Res. Ven. Rattlesn., p. 122 (1861).—COPE, Proc. Phila. Acad., 1866, p. 309.—ALLEN, Proc. Boston Soc. N. H., XVII, 1874, p. 69, extr. p. 39.—COUES, in Wheeler's Surv. West 100 Mer., V, p. 604 (1875).

1852.—*Crotalus lecontei*, HALLOWELL, Proc. Phila. Acad., VI, 1852, p. 180.—HALLOWELL, in Sitgreave's Exp. Zuñi and Colo. Riv., p. 139 (in part only) (1854).—*Caudisona lecontei*, COPE, in Mitchell's Res. Ven. Rattlesn. (p. 121) (1861).—HAYDEN, Geol. Nat. Hist. Upp. Missouri, p. 177 (1862).

859.—*Crotalus adamanteus*, var. *confluentus*, JAN, Rev. et Mag. Zool., 1859, No. 12, extr. p. 28.—JAN, Elenc. Sist. Ofid., p. 124 (1863).

1865.—*Crotalus durissus*, MAX VON WIED, Verz. Rept. Reise Nord. Amer., p. 65, pl. VII, figs. 1–3 (not of LINN.).

1866.—*Caudisona confluenta*, var. *lecontei*, COPE, Proc. Phila. Acad., 1866, p. 307 (not of 1883).

1875.—*Crotalus adamanteus*, subsp. *atrox*, YARROW, in Wheeler's Surv. West 100 Mer., V, p. 529 (not of B. & G.).

1875.—*Crotalus lucifer*, YARROW, in Wheeler's Surv. West 100 Mer., V, p. 529 (not of B. & G.).

1875.—?*Caudisona lucifer*, var. *cerberus*, COUES, in Wheeler's Surv. West 100 Mer., V, p. 607.

1883.—*Crotalus confluentus*, var. *confluentus*, COPE, Proc. Phila. Acad., 1883, p. 11.—COPE, Proc. Phila. Acad., 1892, p. 336.—COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 692 (1892).—TAYLOR, Amer. Natural., XXVI, Sept. 1892, p. 752.

1883.—*Crotalus confluentus*, var. *pulverulentus*, COPE, Proc. Phila. Acad., 1883, p. 11.—*Crotalus confluentus pulverulentus*, COPE, Proc. U.S. Nat. Mus., XIV, 1891, p. 692 (1892).

Figures.—BAIRD and GIRARD, in Marcy's Expl. Red River, Zool., pl. I (1854).—COOPER, Pac. R. R. Rep., XII, pt. iii, pl. XII (1859).—DUMÉRIL et BIBRON, Erpét. Génér., Atlas, pl. LXXXIV bis, fig. 4 (1854).

*Description.**—Head subtriangular. Plates on top of head squamiform, irregular, angulated, and imbricated; scales between superciliaries (supraoculars) small, numerous, uniform. Four rows of scales between the suborbital series (which only extends to the center of the orbit) and the labials. Labials 15 or 18, nearly uniform. Dorsal series 27–29. Dorsal blotches quadrate, concave before and behind; intervals greater behind. Spots transversely quadrate posteriorly, ultimately becoming 10 or 12 half rings. Two transverse lines on superciliaries, inclosing about one-third. Stripe from superciliary to angle of jaws crosses angle of the mouth on the second row above labial. Rostral margined with lighter.

This species bears a considerable resemblance to *C. atrox*, but the body is more slender and compact. Scales on the top of the head anterior to the superciliaries nearly uniform in size. Line of scales across from one nostril to the other consists of 6, not 4 as in *C. atrox*. Superciliaries more prominent. Labial series much smaller. Upper anterior orbitals (preoculars) much smaller, as also is the anterior nasal.

*From S. F. Baird's description of specimens from Wichita Mts. and Texas, in Baird and Girard's N. Am. Serp., p. 8.

Scales on the top of the head less carinated. Scales between superciliaries smaller and more numerous, 5 or 6 in number instead of 4. Two lateral rows of scales smooth, first, second, and third gradually increasing in size. Scales more linear than in *C. atrox*.

General color yellowish brown with a series of subquadrate dark blotches, with the corners rounded and the anterior and posterior sides frequently concave, the exterior convex (fig. 58). These blotches are 10 or 11 scales wide and 4 or 5 long, lighter in the center, and margined for one-third of a scale with light yellowish. The intervals along the back light brown, darker than the margins of the blotches. Anteriorly the interval between the dark spots is but a single scale; posteriorly it is more, becoming sometimes 2 scales, where also the spots are more rhomboidal or lozenge-shaped; nearer the tail, however, they become transversely quadrate. The fundamental theory of coloration might be likened to that of *Crotalus adamanteus*, viz, of 40 or 50 light lines decussating each other from opposite sides; but the angles of decussating, instead of being acute, are obtuse, and truncated or rounded off throughout. Along the third, fourth, and fifth lateral rows of scales is a series of indistinct brown blotches covering a space of about 4 scales and falling opposite to the dorsal blotches; between these blotches, and opposite to the intervals of the dorsal blotches, are others less distinct. Along the fifth, sixth, seventh, and eighth rows is a second series of obsolete blotches, each covering a space of about 4 scales, and just opposite the intervals between the dorsal spots. The dorsal and lower series are separated by an interval of 3 scales, this interval light brown. Beneath the color is dull yellowish, and 10 or 12 darker half rings are visible on the tail.

In point of coloration the principal features, as compared with *C. atrox*, lie in the dorsal blotches, being disposed in subquadrate spots instead of subrhomboids; the intervals thus forming bands across the back perpendicular to the longitudinal axis. This tendency to assume the subquadrangular pattern has broken up the chainwork into isolated portions, as in *Coluber eximius* or *Crotalophorus tergeminus* (*Sistrurus catenatus*). The intervals of the dorsal blotches are wide and darker in the middle, while in *C. atrox* they are narrow, not linear, and unicolor. The sides of the head (fig. 59) present the usual light stripe from the posterior extremity of the superciliary; it passes, however, to the angle of the jaw on the neck, along the second row of scales above the labials. A second stripe passes in front of the eye to the labials, widening there. A small, light vertical bar is seen below the pit and another on the outer edge of the rostral. On the superciliaries are seen two light transverse lines inclosing a space nearly one-third of the whole surface. In *C. atrox* there is a single median line. Sometimes, as in *C. atrox*, the single blotches on the nape are replaced by two elongated ones parallel to each other.

Variation.—There is some slight variation in the size of the scales covering the top of the head, which is, in a general way, correlated with the latitude of the locality, but the character is so exceedingly unstable and apparently unsupported by any other character that it would be unprofitable and misleading to adopt any subspecies at the present stage of our knowledge, at least. This instability in the size of the head scales sometimes goes so far as to fuse them into nearly regular shields on the snout and between the eyes, exactly in the same manner as in certain specimens of *Crotalus atrox*, which have been called *Crotalus scutulatus*, the result being that this so called species or subspecies is a mixture of *atrox* and *confluentus*. Such scutulated specimens have been found both in Arizona and in Montana, the two extremes of its geographical distribution. A specimen from Fort Hayes is recorded by Garman as having the outer edge of the supraocular produced into a horn, as in *C. cerastes*.

The color varies also greatly being sometimes duller, sometimes brighter, lighter or darker, depending upon age, season, condition of skin, climate, and the predominating color of the surroundings, but I have seen no differences of such a character or stability as to render the recognition of geographical races possible or profitable.

Geographical distribution.—Broadly speaking, the Prairie Rattlesnake occupies the area bounded in the East by the ninety-sixth meridian and the Upper Missouri Valley; by the main divide of the Rocky Mountains in the West; by the thirty third parallel in Texas and the Mexican boundary further west in the South; and by the fiftieth parallel in the North. In the Northeast its distribution appears to be limited by the watershed between Missouri and the Red River of the North, according to Dr. Coues (Bull. Geol. Surv. Terr. IV, 1878, p. 267), who cellected numerous specimens along the Canadian border between this watershed and the crest of the Rockies. He also states that it is to be considered fairly common in the region of the Upper Missouri and Milk River and some of their northern tributaries; its range thus extending some distance into the British Possessions, where Mr. James M. Macoun informs me that it is most abundant from Medicine Hat, on the Saskatchewan, to the boundary. In the region just south of the above, Dr. J. A. Allen, while attached to the Union Pacific Railroad expedition, found it common, especially in the bad lands of the Little Missouri and along the Yellowstone, outnumbering all the other ophidians together, and on the expedition of 1872 not less than 2,000 were killed (Proc. Boston Soc. Nat. Hist., XVII, 1874, p. 69). In Nebraska, Taylor (Amer. Natural., XXVI, Sept. 1892, p. 752) observes that it was formerly abundant all over the State, but that it is now confined almost wholly to the middle and western part, where it is by no means rare. The distribution in Kansas, Oklahoma, and Indian Territory is very similar, while in northwestern Texas it is recorded from between the main

forks of the Brazos River and on the Llano Estacado as far south as Cañon Blanco (Cope, Zool. Pos. Texas, p. 24; Proc. Phila. Acad. 1892, p. 336). Further west Capt. Pope collected specimens at the Pecos River near the thirty-second parallel. As we leave the plains in going west we find this species ascend higher into the mountains, as it is not uncommon in New Mexico and Arizona and Colorado above 5,000 feet altitude. Even in Montana and Idaho it reaches this elevation, at least in places, though it probably does not occur much higher. Although the main divide of the Rocky Mountains in this northern region seems to be the limit of its extension to the west, yet in at least one place where there is no high crest to obstruct its passage across, has it been found on the western slope, viz; at Lemhi, Idaho, in which locality it was collected by parties of Dr. Merriam's Idaho exploration party, as recorded by me in North American Fauna, No. 5, p. 111 (1891).

Habits.—The Prairie Rattlesnake being one of the smaller species, as it seldom reaches a length of over 4 feet with a proportionately slender body, does not seem to be a very dangerous snake. Dr. Allen, as referred to above, found it so common in the region visited by the expedition that several hundred were killed by the different members, yet the only casualty resulting from it was one horse bitten. On the expedition of 1872 not less than *two thousand* were killed and not a man nor an animal was bitten. Allen also comments upon the fact that they were found abroad quite late in the season, as they were met with quite frequently after several severe frosts had occurred. During July two pairs were found *in coitu*, indicating the season at which they pair. Dr. O. P. Hay (Proc. U. S. Nat. Mus., XV, 1892, p. 387), on the other hand, quotes Prof. S. W. Williston as stating that the sexes pair in May.

Taylor (*l. c.*) found its food habits similar to those of the Massasauga. It is the species often found in or around the homes of the prairie dogs, where they are most abundantly found during the breeding season of the dogs.

Professor Cope records a similar observation (Proc. Phila. Acad., 1892, p. 336) and remarks that the snake protects itself by retreating quickly into the holes of the prairie dogs. The popular belief that these rodents and the rattlesnakes live together because of any special friendship is certainly erroneous, as there can be no doubt that the latter to a great extent feed upon the offspring of the former.

In addition to the hibernation, which, according to Dr. Coues, lasts about six months, terminating with the loosening of the ground from frost, Dr. Suckley (Pac. R. R. Rep., XII, Pt. iii, p. 296) observed these snakes in a more or less sluggish and stupid condition during the drought of summer, a condition which he calls "æstivation."

THE PACIFIC RATTLESNAKE.

Crotalus lucifer,* Baird and Girard

Plate 13.

1842.—? *Crotalus oregonus*, HOLBROOK, N. Am. Herpet., 2 ed., III, p. 21, pl. III.—DE KAY, Zool. N. Y., III, p. 57 (1842).—BAIRD and GIRARD, N. Am. Serp., p. 145 (1853).—BAIRD, Pac. R. R. Rept. X, p. 14, pl. XXIV, fig. 6 (1859).—COPE, Proc. Phila. Ac., 1859 (p. 337).

1852.—*Crotalus lucifer*, BAIRD and GIRARD, Proc. Phila. Acad., VI, p. 177.—BAIRD and GIRARD, Cat. N. Am. Serp., p. 6 (1853).—GIRARD, U. S. Expl. Exp., Herpet., p. 187, pl. XV, figs. 1–6 (1858).—BAIRD, Pac. R. R. Rep., X, Williamson's R. in 1855, p. 10 (1859).—Cope, Proc. Phila. Acad., 1859, p. 337.—Cope in Wheeler's Surv. West 100 Mer., V, p. 533 (1875).—Cope Bull. U. S. Nat. Mus., No. 1, p. 33, (1875).—COOPER, Pac. R. R. Rep., XII, Pt. iii, p. 295 (1860).—LORD, Natural. Vancouv. Isl., II, p. 303 (1866)—LOCKINGTON, Amer. Natural., 1880, p. 295.—GARMAN, Rept. Batr. N. Am., I, Ophid., p. 114 (1883).—YARROW, Bull. U. S. Nat. Mus., No. 24, Check List, pp. 12, 76 (1883).—TOWNSEND, Proc., U. S. Nat. Mus., X, 1887, p. 239.—BEHR, Proc. Calif. Acad. Sc. (2) I, June 1888, p. 94.—STEJNEGER, N. Amer. Fauna, No. 5, p. 111 (1891).—STEJNEGER, N. Amer. Fauna, No. 7, p. 218 (1893.)—COUES, Hist. Exp. Lewis and Clark, III, pp. 898, 968 (1893).—DENBURGH, Bull. U. S. Fish Comm., 1894, p. 57.—*Caudisona lucifer*, COPE, in Mitchell's Res. Ven. Rattlesn., p. 121 (1861).—COPE, Proc. Phila. Acad., 1866, p. 309.—COUES, in Wheeler's Surv. West 100 Mer., V (p. 606) (1875).

1875.—*Crotalus confluentus*, (part) YARROW, in Wheeler's Surv. West 100 Mer., V, p. 530.

1877.—*Crotalus adamanteus atrox*, STREETS, Bull. U. S. Nat. Mus. No. 7, p. 40 (not of B. & G.)

1883.—*Crotalus confluentus lucifer*, COPE, Proc. Phila. Acad., 1883, pp. 11, 19, 22.—COPE, Proc. U. S. Nat. Mus., XIV, 1891, p. 692 (1892).—COPE, Proc. Phila. Acad., 1893, p. 183.

1859.—*Crotalus lecontei*, HALLOWELL, Rep. Pac. R. R., X, Williamson's Route in 1853, p. 18 (not of 1852).

1863.—*Crotalus adamanteus*, var *lucifer*, JAN, Elenc. Sist. Ofid., p. 124.

1883.—*Crotalus oregonus*, var *lucifer*, GARMAN, Rept. Batr. N. Am., I, Ophid., p. 173.

1892.—*Crotalus confluentus lecontei*, COPE, Proc. U. S. Nat. Mus., XIV, p. 692 (not of Hallow.).

1868.—?*Crotalus hallowelli*, COOPER, in Cronise, Nat. Wealth Calif., p. 483 (nom. nud.).—COOPER, Proc. Calif. Acad. Nat. Sc., IV, 1870, p. 68 (nom. nud.).

Figures.—GIRARD, U. S. Expl. Exp., Herpet., Atlas, pl. XV, figs. 1–6 (1858).—BAIRD, Pac. R. R. Rep., X, Williamson's Route in 1855, pl. XI (1859).—HALLOWELL, Pac. R. R. Rep., X, Williamson's Route in 1853, pl. III (1859).—Standard Natural History, III, pl. facing, p. 398 (1885).

Description.†—Muzzle broad. Scales between the superciliaries (supraoculars) numerous, small, and uniform. Plates on the top of head, 4 prefrontal, (internasals) 4 postfrontal (prefontals), or else irregular. Three rows scales between the suborbitals and labials. Labials 16 above; first and fifth largest; 15 below. Dorsal rows 25, exterior

* Probably so named with reference to its supposed diabolical appearance or nature.

† The original description by S. F. Baird, in Baird and Girard's N. Am. Serp., p. 6.

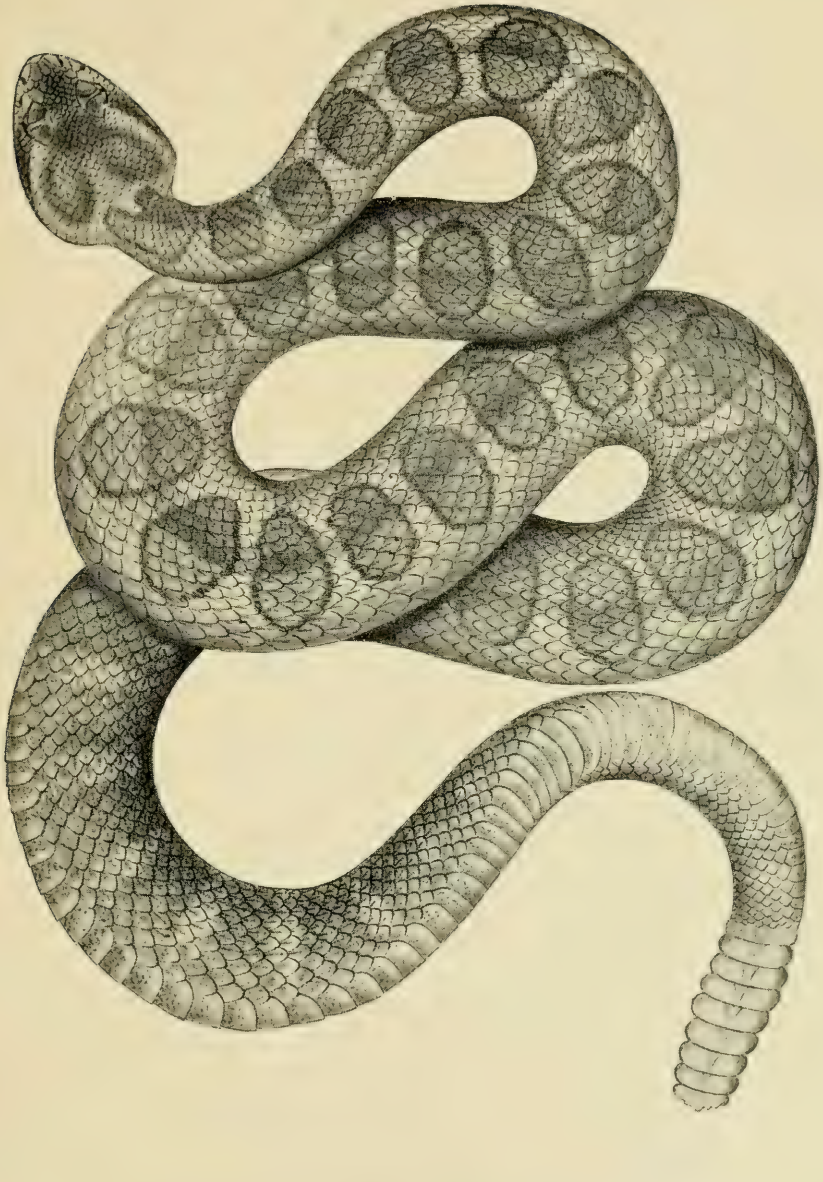
smooth, second and third with absolute carination. Tail and posterior portion of body with 16 or 17 half rings. A succession of brown dorsal hexagons or octagons, separated throughout by a narrow lighter line. Light stripe from superciliary crosses the angle of the mouth on the third and fourth row above labial.

Head very broad anteriorly, outline little tapering. Head above covered with many small tuberculiform scales, showing a substelliform radiation. Interval between superciliary plates filled with small scales, nearly uniform in size; row bordering the superciliaries very small. Scales in front of the superciliaries variable; in one specimen there are two rows of four each, of considerable size; in another they are larger than the rest, but irregular. Scales on the cheeks large, flat, smooth.

Ground color, light brown above. Along the back a series of sub-hexagonal or octagonal blotches, formed by a skeleton of dull yellowish, constituting a dorsal chain. The space thus inclosed of the ground color is margined faintly with dark brown; the width of the interval between the successive blotches is from one-half to 1½ scales. These spots are frequently confluent, two and three running together. Where most distinct the spots are 4 scales long and 11 wide. On each side of this dorsal series is a second, separated by a single row of scales, the blotches extending from the abdominal scutellæ to the fifth or sixth row. These are smaller than the dorsal, and subcircular. Opposite the transverse light bands, and in the open space between four contiguous blotches on the sides, smaller blotches are indistinctly visible. Posteriorly, the spots on the back and sides are confluent and darker; in one specimen forming 17 half rings, encircling the back, leaving about 24 dorsal blotches. Abdomen greenish yellow, more or less clouded with brown at the bases of the scales. Head dark brown; a light line from posterior portion of the superciliaries along the fourth row of supralabial scales back to the angle of the jaws, on the occiput, where it expands into the color of the under part. Upper labials of the same light color behind, rapidly widening anteriorly so as to include whole front and side of the face, leaving only the top of the head dark. The space about the facial pit darker. (See fig. 60).

The theory of coloration is that of decussating lines, which, when they intersect, unite so as to have the angles of intersection truncated.

The species has a general resemblance to *C. atrox* in the arrangement of the blotches, but is darker, and has about 17 dark half rings posteriorly instead of 4 or 5. In *C. atrox* the head is narrower and more triangular, the space between the superciliaries narrow and occupied by angulated larger scales, instead of small tuberculous ones. In *C. atrox* the row bordering the superciliaries is much larger than the rest, and the scales on the top of the head generally more angulated. In *C. lucifer* the line on the side of the head (fig. 60), instead of going directly from the posterior end of the superciliary to the commissures, passes back nearly parallel to the mouth, crossing along the fourth row



PACIFIC RATTLESNAKE,—CROTALUS LUCIFER.
From Baird, Pacific R. R. Rep.

of scales above the labial. The second line in front of the eye is much wider below in *C. lucifer*, and the face generally shows more of white, while the dark portions are much darker.

Variation.—There is a great deal of variation observable in the various specimens before us, particularly in the shape of the head, as well as in the general coloration. As with most of these snakes, the characteristic head pattern becomes obsolete as the individuals grow large, and this character, which is otherwise so constant and reliable in the young, is sometimes difficult of application in very large and old ones. However, I have yet to see a specimen in which the essential parts of it can not be made out if care be exercised. The ground color also varies greatly according to climatic and other local conditions, very dark, nearly black specimens with strongly contrasted color pattern in whitish being frequently found near the coast, or in mountain regions with a very moist climate, while, on the other hand, specimens living in the arid region among light-colored surroundings are often greatly faded, as shown by various specimens from Utah and other portions of the great basin. Upon an examination of a large series, however, I can not find any more reliable or stable color difference than is usual in most species covering a large area and subject to varying, often very restricted, local influences, and I can not see my way clear to recognize any subspecies of *C. lucifer* on this account.

The difference in the outline of the snout and the proportionate width of the head varies apparently greatly, as stated, though hardly more than in several other species. These differences depend greatly upon the general condition of the snake, upon the amount of venom in the gland, and, in alcoholic specimens, upon their state of preservation, specimens dried and hardened in too strong alcohol showing a much more pointed snout than those preserved in a moderately strong solution, while in soft examples kept in a too weak fluid the face is often swollen and rounded.

It appears probable that Holbrook's *C. oregonus* is based upon such a hardened specimen, but as I have not been able to examine it I have refrained for the present from exchanging the well-known name *lucifer* for the older appellation. The material at my disposal is not sufficiently extensive, nor is its quality sufficiently satisfactory to allow me to pass a final judgment upon the question whether there really occurs one or two subspecies or forms on the Pacific province, a question which therefore must be considered still open.

Geographical distribution.—*Crotalus lucifer* is the characteristic snake of the Pacific province as well as the northern portion of the Great Basin. In southern California it occurs on the west slope of the coast ranges of San Diego and Los Angeles counties from the sea level high up into the mountains. It is even found on at least some of the islands off the coast, as, for instance, Santa Catalina Island and Los Coronados. In the southern part of the great interior valley of California this

Rattlesnake is equally at home in the foothills and on the higher slopes of the Sierra Nevada, at least up to an altitude of 8,600 feet above the level of the sea. In the lower cultivated country it is rapidly becoming extinct in some places, while on the other hand there are records of its increase in other localities. Dr. Behr (Proc. Calif. Acad. Sc. (2), I, 1888, p. 94) has called attention to this curious circumstance with regard to its occurrence in various localities around San Francisco Bay. Our records for northern California are less complete, but it is undoubtedly equally widely distributed in all suitable localities, though probably not so high up in the mountains. Townsend (Proc. U. S. Nat. Mus., x, 1887, p. 239) found it "pretty generally distributed, but more numerous in the foothills of Shasta County than elsewhere. Very few snakes were met with in the elevated coniferous forests, and none high up on the mountains." In Oregon and Washington this species is still common in places. In the early days of these states Dr. Suckley (Pac. R. R. Rep., XII, Pt. iii, p. 295) found them to be so numerous at the Dalles as to be very annoying, having been known to enter dwelling houses. Dr. Cooper (*l. c.*) states that they are much less numerous north of the Columbia River than south, and also that none are found west of the Cascade Range, except an occasional straggler carried down the Columbia River. However that may be in Washington, it certainly does not hold for Oregon, as the National Museum possesses a specimen from Fort Umpqua (No. 4234). Lord (Naturalist in Vancouver Island, 1866, p. 303) says that at the Dalles, the Snake, Pelouse, and Spokane rivers, indeed along the entire boundary line between the British Possessions and the United States west of the continental divide, and high up in the Rocky Mountains "its name is *legion*." The exact northern boundary of the species in British Columbia is not recorded, but Mr. James M. Macoun, of the Geological Survey of Canada, writes me that it is confined to a small area in the interior of British Columbia, bounded on the west by Lytton, on the North Thompson River, being found in that latitude as far east as Shuswap Lake. The farthest eastern record is about 10 miles east of Okanagan Lake, in the vicinity of which they are very abundant.

This species evidently follows up the tributaries of the Columbia into the interior, for a number of specimens were collected in Idaho, at Big Butte and Little Lost River, by parties of Dr. Merriam's Idaho exploration party (N. Am. Fauna, No. 5, 1891, p. 111).

Whether the distribution of this species into Nevada is continuous to the north with the Oregon and Idaho localities remains yet to be seen, though it seems probable. It is also continuous into the eastern portion of northern California. Robert Ridgway, during King's exploration of the fortieth parallel, found it excessively abundant on the little island in the Pyramid Lake, and also collected it at the Truckeé River, and later explorers have also recorded it as common from that neighborhood. Farther east it has been obtained in Nevada and Utah by the various Government exploring parties at altitudes of 5,000 feet

and upwards, and in the southern portion of these States this Rattlesnake almost certainly does not descend below 5,000 feet. Dr. Merriam's various parties, which in 1891 were scouring the mountain ranges and deserts of Nevada and Utah south of the thirty-eighth parallel, failed to find a single specimen, so that it seems almost certain that it does not occur there. The records of this species from Arizona are very dubious, as the specimens so recorded which I have had an opportunity to examine have either been misidentified, or else the locality was very doubtful.

Habits.—The Pacific Rattlesnake undoubtedly in a general way shares in the habits of its congeners, but is perhaps even less offensive than most of them in spite of the fact that it often reaches dimensions which might make it dangerous enough. It seems to prefer rocky places, whether timbered or not, but it does not invade the desert proper.

The Tiger Rattlesnake.

Crotalus tigris,* Kenn.

Plate 14.

1859.—*Crotalus tigris*, Kennicott, U. S. and Mex. Bound. Surv., II, Rept., p. 14.—Baird, Pac. R. R. Rep., X, Reptiles, p. 16 (1859).—Cope, Proc. Phila. Acad., 1859, p. 338.—Cope, in Wheeler's Surv. W. 100 Mer., V, p. 534 (1875).—Cope, Bull. U. S. Nat. Mus., No. 1, Check-list, pp. 33, 90 (1875).—Cope, Proc. U. S. Nat. Mus., XIV, 1891, No. 882, p. 693 (1892).—Cooper, in Cronise, Nat. Wealth Calif., p. 483 (1868).—Cooper, Proc. Calif. Acad. Nat. Sc., IV, p. 66 (1870).—Garman, Rept. Batr. N. Am., I, Ophid., pp. 117, 175 (1883).—Garman, List Rept. Batr. N. Am., p. 35 (1884).—Yarrow, Bull. U. S. Nat. Mus., No. 24, Check-list, pp. 12, 74 (1883).—Yarrow, in Buck's Ref. Handb. Med. Sc., VI, p. 166 (1888).—Stejneger, N. Am. Fauna, No. 7, Death Vall. Exp., p. 214 (1893).—Merriam, N. Am. Fauna, No. 7, p. 215 (1893).—*Caudisona tigris*, Cope, in Mitchell's Res. Ven. Rattlesn., p. 122 (1861).—Cope, Proc. Phila. Acad., 1866, p. 309.—Coues, in Wheeler's Surv. W. 100 Mer., V, p. 608 (1875).

Figures.—Baird, Mex. Bound. Surv., II, Rept., pl. IV (1859).—Baird, Pac. R. R. Rep., X, Rept., pl. XXX, fig. 1 (1859).

Description.†—Body slender; head small, very much depressed, narrow behind; nose remarkably broad and obtuse; whole outline of head nearly quadrangular. Superciliaries (supraorbitals) and frontals smooth; space between superciliaries very wide; 4 frontal plates (internasals), 6 post-frontals (pre-frontals). Two rows of scales between suborbital chain (which is complete) and labials. Labials 14 above, 13 to 14 below. Dorsal rows 21 to 23; very slightly carinated. Dorsal scales broad, rounded behind. Color, yellowish ash above, with rather small, indistinct dorsal brown blotches anteriorly; 2 posterior thirds of body banded with brown.

* From the Latin *tigris*, a tiger, with reference to its yellowish color and tiger-like cross streaks.

† Original description by R. Kennicott in Mex. Bound. Surv., II, Rept., p. 14, from type specimen, U. S. Nat. Mus., No. 471.

Variation.—Beyond the usual individual variation in number of scale rows, loreals, labials, size of scales on top of head, etc., nothing special has been noticed in the material examined. The color varies from whitish to tawny. The head markings are rather indistinct, especially the postocular stripe, which is often lost in the dense sprinkling of minute black dots covering the sides of the head.

Geographical distribution.—This rare snake was formerly only known from a few localities in southern Arizona near the Mexican boundary, until in 1891 the Death Valley exploration under Dr. Merriam extended its range very materially into the desert mountains of southern California and Nevada south of the thirty-seventh parallel, from Owens Valley to the Great Bend of the Colorado, where these snakes were found to be quite common, as Dr. A. K. Fisher and his party killed no less than nineteen in or near Shepherd Canyon, Argus Range, California, during the latter part of April and first week of May, 1891 The vertical range is considerable, as Dr. Merriam's party collected specimens at altitudes varying between about 2,000 and 6,500 feet above the sea.

Habits.—The Tiger Rattler which has received its name, not from any extreme degree of bloodthirstiness or fatal aggressiveness, but from its tawny color and marked cross stripes, seems partial to the barren mountain ranges with their rocks and crevices in preference to the desert valleys surrounding them. It is one of the smaller species and comparatively harmless, though, of course, a bite when inflicted might be serious enough.

During the Death Valley expedition under Dr. C. Hart Merriam, a specimen was found in a wood rat's nest that was dug open. Its stomach contained a kangaroo rat (*Dipodomys*) and a pocket mouse (*Perognathus*), indicating nocturnal habits.

Mr. Stephens, of the same party, on April 15, 1891, killed a pair of these snakes which were on a ledge of rock, standing erect with their heads near together, "apparently playing." They were probably pursuing their amours, and the time would thus indicate the pairing season of the species.

The Horned Rattlesnake.

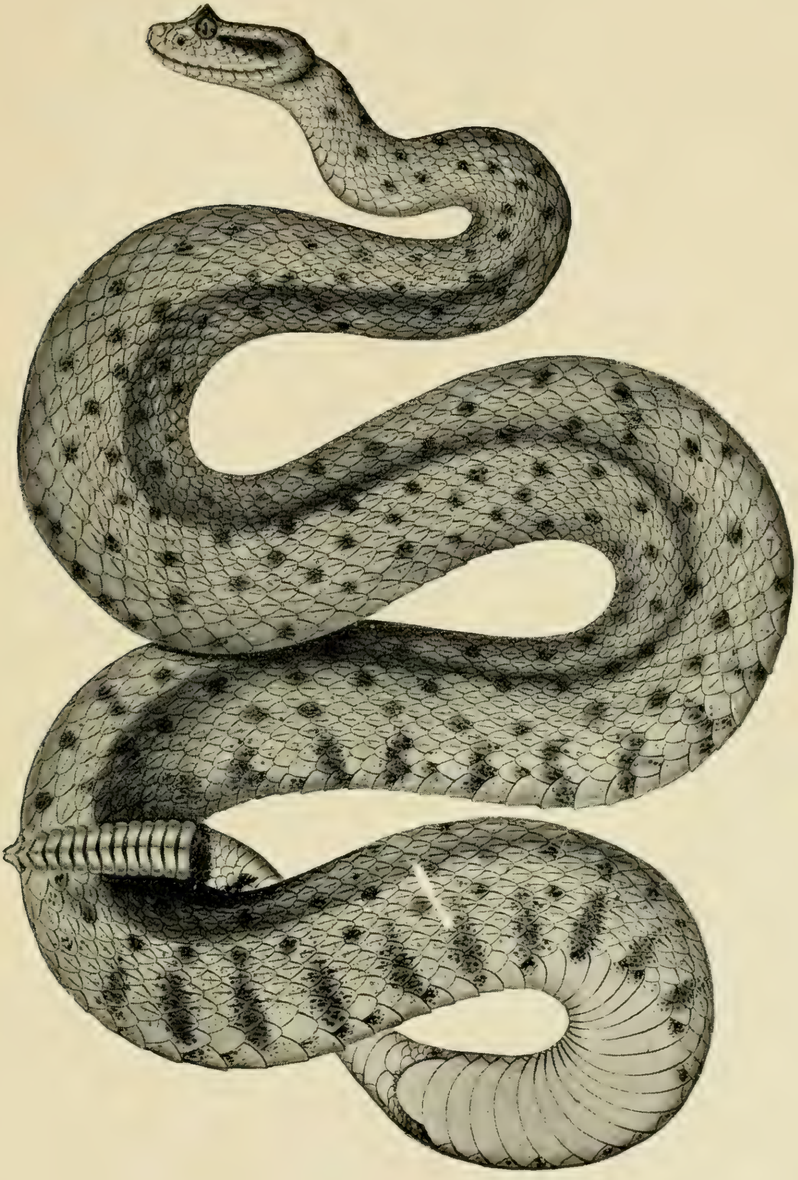
*Crotalus cerastes,** Hallowell.

Plate 15.

1854.—*Crotalus cerastes,* Hallowell, Proc. Phila. Acad., 1854 (p. 95).—Hallowell, Pac. R. R. Rep., x, Williamson's Route (p. 17) (1859).—Baird, U. S. Mex. Bound. Surv., ii, Rept., p. 14 (1859).—Baird Pac. R. R. Rep., x, Reptiles, p. 16 (1859).—Cope, Proc. Phila. Acad., 1859, p. 337.—Cope, Bull. U. S. Nat. Mus., No. 1, Check-list, p. 33 (1875).—Cope, in Wheeler's Surv. W. 100 Mer., v, p. 534 (1875).—Cope, Proc. U. S. Nat. Mus., xiv, 1891, No. 882, p. 694 (1892).—Jan, Elenco Sist. Ofid., p. 124 (1863).—

*From the Greek κεράστης (kerastes) in allusion to the cerastes, or horned serpent of the deserts of Northern Africa.

TIGER RATTLESNAKE,—CROTALUS TIGRIS.
From Baird, Rep. Mex. Bound. Surv



HORNED RATTLESNAKE,—CROTALUS CERASTES.
From Baird, Rep. Mex. Bound. Surv.

COOPER, Proc. Calif. Acad. Nat. Hist., IV, p. 67 (1874).—YARROW, Bull. U. S. Nat. Mus., No. 24, Check-list, pp. 12, 73 (1883).—YARROW, in Buck's Ref. Handb. Med. Sc., VI, p. 166 (1888).—GARMAN, Rept. Batr. N. Am., I, Ophid., pp. 116, 175 (1883).—GARMAN, List N. Am. Rept. Batr., p. 35 (1884).—STEJNEGER, N. Am. Fauna, No. 7, Death Vall. Exp., p. 216 (1893).—MERRIAM, N. Am. Fauna, No. 7, p. 217 (1893).—*Caudisona cerastes* COPE, in Mitchell's Res. Ven. Rattlesn., p. 124 (1861).—COPE, Proc. Phila. Acad., 1866, p. 309.—COPE, Proc. Phila. Acad., 1867, p. 85.—*Æchmophrys cerastes* COUES, in Wheeler's Surv. W. 100 Mer., V, p. 609 (1875).

Figures: HALLOWELL, Pac. R. R. Rep., X, Williamson's Route, pl. IV, fig. 1 (1859).—BAIRD, Pac. R. R. Rep., X. Reptiles, pl. XXXV, fig. 4 (1859).—BAIRD, U. S. Mex. Bound. Surv., II, Rept., pl. III (1859).—JAN, Icon. Ophid., livr. 46, pl. III, fig. 5 (1874).

*Description.**—Head small, angles rounded; nose obtuse, much depressed; rostral as broad as high; nostril in the middle of a single large plate (figs. 66, 67). Lateral edge of superciliary plate (supraocular) elongated into a horn-like process directed upward over the eye. Two

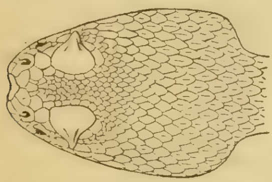


Fig. 66.
HEAD OF CROTALUS CERASTES, TOP VIEW.
Cat. No. 482, U. S. N. M

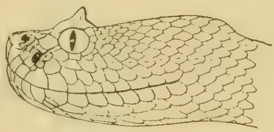


Fig. 67.
HEAD OF CROTALUS CERASTES, SIDE VIEW.
Cat. No. 482, U. S. N. M.

rows of scales between the suborbital series (which is complete of large scales) and the labials. Upper labials 11 to 13, lower 12 to 13. Dorsal rows of scales 21, slightly carinated; each scale along the middle of the back with a tubercular swelling toward the center. Crown tubercular. Entire head and upper parts of a slight yellowish, with a dorsal series of small, indistinct blotches, below which are several irregular rows of isolated brown dots. A narrow, brown stripe extends from the orbit back over the angle of the mouth.

Geographical distribution.—In a general way the horned rattlesnake inhabits the same region as *C. tigris*, viz, southern Arizona, California, and Nevada, but while the latter inhabits the mountain ranges of this area the former is more confined to the desert plains and valleys.

The type locality is Mojave Desert, whence Dr. Merriam, in 1891, rediscovered it and secured specimens. His Death Valley expedition brought home numerous specimens from nearly all the suitable localities visited, and he found it to be "the characteristic snake of the Lower Sonoran deserts of the Great Basin, from southern California easterly across southern Nevada to Arizona and southwestern Utah." We have received specimens from Mr. R. C. Orcutt, who obtained them

*Description by R. Kennicott, in Mex. Bound. Surv., II, Rept., p. 14, from specimen in U. S. Nat. Mus., No. 482.

in the Colorado Desert, San Diego County, Cal., near Salton, from Chrystoval, Ariz., and other places in the Gila and Colorado deserts. It occurs at least as far east as Tempe, where we have specimens from Dr. Wortman, and I myself have collected it at Vulture, Ariz.

Habits.—The Horned Rattlesnake is known locally as the "sidewinder" throughout its range, as Dr. Merriam explains, on account of its peculiar mode of progression:

When disturbed it moves away sideways, keeping its broadside towards the observer instead of proceeding in the usual serpentine manner.

Its feeding habits seems to be similar to those of the Tiger Rattler, as a specimen collected by the Death Valley expedition contained a kangaroo rat and 2 pocket mice. As it is a small snake it is probably comparatively harmless, though it has a very bad reputation, but there is nothing to indicate that its venom is more virulent than that of the other Rattlesnakes. Dr. Merriam's parties brought home 15 specimens and killed a good many more, but no one was bitten.

As to the breeding habits we have the following observation by Dr. Merriam:

During the latter part of April and the early part of May these Rattlesnakes were often found in pairs and were doubtless mating. At such times they remained out in plain sight over night, instead of retreating to holes or shelter under desert brush, and on two occasions they were found by us on cold mornings so early that they were too chilled to move until considerably disturbed. I stepped on one of these by accident as it lay in a compact coil with its head in the center, but it was held so firmly by my weight that it was unable to strike. A moment before I had killed its mate.

THE GREEN RATTLESNAKE.

Crotalus lepidus,* Kennicott.

Plate 16.

1861.—*Caudisona lepida*, KENNICOTT, Proc. Phila. Acad., XIII, 1861, p. 206.—COPE, in Mitchell's Res. Ven. Rattlesn., p. 124 (1861).—*Aploaspis lepida*, COPE, Proc. Phila. Acad., 1866 p. 310.—COPE, in Wheeler's Surv. W. 100 Mer., V, p. 535 (1875).—COPE, Bull. U. S. Nat. Mus., No. 1, Check-list, p. 33 (1875).—YARROW, Bull. U. S. Nat. Mus., No. 24, Check-list, pp. 12, 189 (1883).—*Crotalus lepidus*, COPE, Proc. Phila. Acad., 1883, p. 13.—COPE, Proc. U. S. Nat. Mus., XIV, 1891, No. 882, p. 692 (1892).—GARMAN, Rept. Batr. N. Am., I, Ophid., pp. 117, 175 (1883).

Figures.—None.

*Description.**—The top of the muzzle is covered by 8 smooth scuta; the rostral plate is rather low, and is in contact with the prenasal; there are 2 preoculars and 2 loreals; and but 2 scales separate the orbit from the superior labial scuta. Of the latter there are 12 occipital scales smooth. Scales of body in 23 rows, the 2 external on each side smooth. Gastrosteges (ventrals), 153; urosteges (subcaudals), 27. The rattle consists of 7 segments and a button, and narrows gradually towards the extremity (fig. 68).

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* From the Latin *lepidus*, pleasant, nice, smooth.

GREEN RATTLESNAKE, CROTALUS LEPIDUS.
From a specimen in the U. S. National Museum.

The color above is greenish gray, which is crossed by 19 jet-black rings on the body (fig. 54), which do not extend on the abdomen. These rings are 2½ scales wide on the middle line, and narrow downwards on each side so as to cover but 1 scale in width. The scales which border the annuli are half black and half green, the effect of which is to give the edge of the ring a turreted outline. The edges of the ground-color are paler than any other part of the scales, thus throwing the black into greater relief. A large black spot, shaped like 2 hearts side by side with the apices posterior, marks the nape, and there is an irregular small black spot on each side of the occiput. Some black specks between the orbits. No other marks on the head. Near the middle of the gray spaces of the body some of the scales of many of the rows have black tips. The tail is light brown above and has a basal broad black, and 2 other narrow brown annuli. Below, dirty white with closely placed shades of brown.

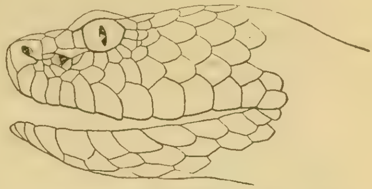

Fig. 68.
HEAD OF CROTALUS LEPIDUS, SIDE VIEW.
Cat. No. 21057, U. S. N. M.

Variation.—Prof. Snow, in 1884, in a letter to the reptile department of the National Museum, describes the fresh color of the specimen just described, taken by him at the head of Water Canyon, New Mexico, in August of 1881, from memory, as being of "an unmistakable glaucous or grayish green" which contrasted beautifully with the jet-black bands. In the specimens in the National Museum the bands are brown in the center, black at the edges.

In the scutellation of the head there is some variation, but nothing out of the unusual. The nostrils are comparatively small, and Kennicott originally described the species as having them situated in an undivided nasal, which afterwards led Cope to institute the genus *Aploaspis*. The two heads upon which the species was originally based do not seem to be in existence any more, but in the specimens which I have examined there is certainly a division of the nasal at least below the nostril. The upper preocular appears always to be divided vertically.

In 3 specimens examined by me the scale rows varied from 21 to 23; the ventrals (gastrosteges), from 160 to 163; subcaudals (urosteges), from 24 to 25.

Geographical distribution.—This species, although apparently extremely rare, seems to occur all along our Mexican border, at least from Eagle Pass on the Rio Grande to Yuma on the Colorado. Since the two heads collected by the Mexican Boundary Survey parties at Eagle Pass and Presidio del Norte, no specimens have been recorded from Texas. Prof. Frank Snow, however, in August, 1881, obtained a specimen at the head of Water Canyon, just west of Socorro, N. Mex. Shortly

* Description by E. D. Cope, in Proc. Phila. Acad., 1883, p. 13, from a New Mexican specimen collected by Prof. Frank Snow.

after, Mr. E. W. Nelson sent a specimen to the National Museum from Tucson, Ariz., the one figured, and recently Dr. Thimothy E. Wilcox obtained it at Fort Huachuca in the same Territory. How far it extends south into Mexico we do not know.

Habits.—Nothing is known about its habits except that it is a mountain species, and as it is our smallest crotalus, its bite is probably proportionately less dangerous than that of the others.

THE WHITE RATTLESNAKE.

*Crotalus Mitchellii,** Cope.

Plate 17.

1861.—*Caudisona Mitchellii*, COPE, Proc. Phila. Acad., 1861, p. 293.—COPE, Proc. Phila. Acad., 1866, p. 310.—*Crotalus Mitchellii* COPE, in Wheeler's Surv. West 100 Mer., v, p. 535, (1875).—COPE, Bull. U. S. Nat. Mus., No. 1, Check-list, p. 33 (1875).—COPE, Bull. U. S. Nat. Mus., No. 32, p. 90 (1887).—COPE, Proc. U. S. Nat. Mus., XIV, 1891 (No. 882), p. 694 (1892).—DENBURGH, Proc. Cal. Acad. Sc. (2) IV, 1894, p. 450.

1883.—*Crotalus Mitchelli*, YARROW, Bull. U. S. Nat. Mus., No. 24, Check-list, pp. 12, 73, 189.

1883.—*Crotalus oregonus*, var. *Mitchellii*, GARMAN, Rept. Batr. N. Am., I, Ophid., p. 173.

1891.—*Crotalus pyrrhus*, STEJNEGER, W. Amer. Scient., VII, April, 1891 (publ. June), p. 165 (in part).

Figures.—None.

Description.†—Head depressed (figs. 69, 70), covered with small, irregular scales, posteriorly keeled; anteriorly, and upon the obtuse muzzle, rugged, free at the lateral or hinder edges. Superciliaries (supraoculars) prominent, striate rugose. One loreal; nostril large, prenasal small, higher than long, separated from the rostral and superior labials by small scales. Rostral low, an equilateral triangle. Sixteen superior labials, the last large, 3 rows between them and the orbit; temporals large, smooth. Superior labials, 16. Scales elongate, striate rugose, in 25 rows, all strongly keeled except the first. Crepitaculum (rattle) well developed, of the *C. atrox* type i. e., strongly compressed, having the terminal complete segments as broad as the basal. Gastrosteges (ventrals), 198; urosteges (subcaudals), 26. Total length (excl. crepitaculum), 44 inches; tail, 3 inches 6 l. (Figs. 69, 70.)

The color above and below is grayish yellow. The upper surface of the head is shaded, that of the body coarsely and densely punctulated with brown. The regular aggregation and deepness of these punctulations form a series of about 42 dorsal spots. These are transverse, with produced lateral angles, extending across 12 rows of scales from angle to angle, separated from the adjacent ones by a bright band of

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*Named in honor of Dr. S. Weir Mitchell, of Philadelphia.

†Original description, by E. D. Cope, in Proc. Phila. Acad., 1861, p. 293, from a Cape St. Lucas specimen in Smithsonian Institution.

WHITE RATTLESNAKE,—CROTALUS MITCHELLII.
From a specimen in the U. S. National Museum.

ground color, 1½ scales wide. On the posterior fourth of the total length they form brown cross bands; 5 upon the tail are black on a very light ground, as in *C. atrox.* Anteriorly there is an ill-defined series of spots which are opposite those of the dorsal line. A yellow band extends from the nasal plates anterior to the eye, involving from the ninth to the last superior labial. Superior to this is a brown band extending from the eye and ceasing on a line with the angle of the mouth. Some indistinct brown marks on the top of the head are arranged as follows: One on the inner border of each superciliary; 3 posterior to these, the median short and broad; 4 further posterior, the median pair longer, diverging, reaching the neck.

Variation.—The characters of scutellation hitherto relied upon for distinction between *C. mitchellii* and *C. pyrrhus*, viz, the breaking up of the large horizontal preocular of the former into 2 or more "loreals," does not hold, as shown by specimens more recently received. Mr. Charles Orcutt has sent us a specimen from the Colorado Desert, San Diego

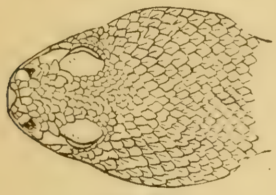

Fig. 69.
HEAD OF CROTALUS MITCHELLII, TOP VIEW.
Cat. No. 12625, U. S. N. M.

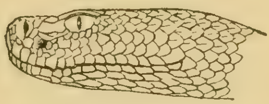

Fig. 70.
HEAD OF CROTALUS MITCHELLII, SIDE VIEW.
Cat. No. 12625, U. S. N. M.

County, Cal. (U. S. Nat. Mus., No. 16353), which is in all other respects almost identical with Belding's specimen from La Paz, Lower California, (No. 12625), but with the preocular on one side divided completely; on the other side, however, only with a faint indication of a division, while another from the same locality has it divided on both sides. These specimens I formerly identified as *C. pyrrhus* on this account, especially as the specimen of so-called *C. pyrrhus* from the Mojave Desert, California, (No. 8669), has the preocular divided on both sides exactly as No. 16501 and the left side of No. 16353. This specimen is, therefore, also a true *C. mitchellii.* The face scutellation of the type of *C. pyrrhus* (No. 6606) is practically identical with that of Dr. Loew's specimen, from the Mojave Desert, and the only difference which I can see consists in the deep reddish color, a difference which can not be regarded as more than subspecific, if indeed it is more than an individual variation. In the California and Lower California specimens the ground color is pale yellowish, almost white.

While reading the proofs of this article I received a paper by Mr. John van Denburgh (Proc. Cal. Acad. Sc. (2) IV, pp. 450–455), who, from an examination of 10 specimens in the California Academy from Lower California, comes to the same conclusion. In these the granules between the nasal and the rostral occur indiscriminately, in one or two

series, and he shows conclusively that there is no difference between *C. mitchellii* and *C. pyrrhus* in so far as scutellation is concerned. He even goes so far as to assert that there is no color difference either, as two of his specimens were "decidedly red." I have myself seen specimens more or less suffused with vinaceous-cinnamon or ochraceous-rufous, but the color is essentially different from the red of the type of *C. pyrrhus*, the status of which I, therefore, consider still unsettled.

Geographical distribution.—Originally described from the Cape region of Lower California from a specimen collected by Xantus and later found in the same locality by Belding, it has but recently been discovered in the Colorado and Mojave deserts of Southern California, those from Colorado Desert being due to Mr. R. C. Orcutt's zeal.

Habits.—This species seems to be a distinctive desert form, but beyond this nothing is known of its habits.

The Red Rattlesnake.

Crotalus Mitchellii pyrrhus,* Cope.

1866.—*Caudisonæ pyrrha*, Cope, Proc. Phila. Acad., xviii, 1866, pp. 308, 310.—Cope, in Wheeler's Surv. West 100 Mer., v, p. 535 (1875).—Coues, in Wheeler's Surv. West 100 Mer., v, p. 608 (1875).—*Crotalus pyrrhus*, Cope, Bull. U. S. Nat. Mus., No. 1, Check-list, p. 33 (1875).—Cope, Wheeler's Surv. West 100 Mer., v, pl. xxii (1875).—Cope, Proc. U. S. Nat. Mus., xiv, 1891 (No. 882), p. 694 (1892).—Yarrow, Bull. U. S. Nat. Mus., No. 24, Check-list, p. 73 (1883).—Garman, N. Am. Rept., i, Ophid., p. 114 (1883).—Stejneger, W. Amer. Scient., vii, April, 1891 (publ. June), p. 165 (in part).

1883.—*Crotalus confluentus*, var. *pyrrhus*, Garman, N. Am. Rept., i, Ophid., p. 173.

1884.—*Crotalus confluentus* (B), Garman, List, N. Am. Rept. Batr., p. 34.

Figures.—Wheeler's Survey West 100 Mer., v, pl. xxii.

The status of this form has been discussed under the head of *C. mitchellii*. It may be well to remark that so far only one specimen of this highly colored form has been obtained, and that the suspicion seems well founded that it is but little more than an individual variation.

Description.†—Scales in 25 series, broad and rounded, the 2 inferior rows smooth. Head short and very obtuse, the nostrils opening subvertically. Superior labials higher than long, 3 rows of temporals smooth; scales of vertex small, keeled; those more anterior, striate. Superciliaries (supraoculars) broad oval, striate. Canthus rostralis none. Inferior labials 15, the first and second margining a plate which meets its fellow in front of the geneials (chin-shields), and is in other species a continuation of the first. Gastrosteges (ventrals), 178; urosteges (subcaudals), 24; joints of rattle, 9. The general tint of this

* From the Greek πυῤῥός (pyrrhos), flame-colored, reddish.

† Original description by E. D. Cope in Proc. Phila. Acad., 1866, pp. 308, 310 from type specimen, U. S. Nat. Mus., No. 6606.

species is a bright salmon red, the scales of the inferior rows punctulate with brown.

Rostral broad as long; 7 [scales] between superciliaries, 3 below orbits; labials, 14; 2 very small preorbitals and 4 loreals. Pale vermillion varied with yellow on the sides of the belly, with numerous arge reddish-bay transverse hexagons, which become transverse bands on posterior two-thirds of length; yellow below.

Geographical distribution.—Only one specimen is known, viz: the type which Dr. E. Coues obtained in Canyon Prieto, not far from Fort Whipple, Arizona.

Habits.—Appears to be a desert form.

THE POISON OF THE POISONOUS SNAKES.

The deadly fluid which from time immemorial has inspired dread and wonder in the human mind, not only by its fatal results but also by its mysterious apparent variability, early became a subject of study and speculation. More than two hundred years ago a Redi and a Charras published their observations on the European vipers and their poison, and all through the eighteenth century experiments with various venoms and their supposed antidotes were common. Some of the investigators of those early dates did good work, notably the Italian savant, Felix Fontana, who arrived at some results which, though contradicted and unheeded by many authors who ought to have known better, have been fully corroborated by the latest investigations.

Very little was discovered as to the real nature of the poison, however, the definite constituency of which the older experimentors had no means of ascertaining. They could only know its grosser physical characteristics, for chemistry, and especially organic chemistry, had not yet reached such a development that it could tackle the intricate problems involved in such investigations. All that was gained was a prodigious number of so-called antidotes, most of which, in their turn, were declared infallible, though very few of them ever gained a general acceptance. In nearly all instances miraculous cures and surprisingly sudden recoveries were recorded, but, sad to say, in other cases even the best reputed remedies failed. It has remained for the last decades to ruthlessly annihilate the claims of most of these "antidotes."

Prince Lucien Bonaparte, in 1843, seems to have been the first to make a chemical analysis of the viper poison, the result of his research being that it is albuminoid or proteid in its nature. The supposed active principle he called echidnine, or viperine. Less than twenty years after, Dr. S. Weir Mitchell, of Philadelphia, commenced a series of analyses and experiments on the poison of the rattlesnake, giving a result similar to Bonaparte's, the corroboration of the albuminoid nature of the venomous substance, which in this case received the name crotaline.

In the meantime organic chemistry, physiology, and bacteriology made immense strides forward. The deadly work of the microbes began gradually to be understood, and their action in the process of putrefaction, as well as their rôle in many of the diseases which in their symptoms recalled those of snake poisoning, became known or suspected; the ptomaïnes and the leucomaïnes were discovered; and the chemists in their improved laboratories became enabled to deal with the proteids, to separate them, and to classify them.

New theories as to the nature of the powerful poison were the necessary result; some thought the toxic property due to the presence of leucomaïnes, or alcaloid bodies; others preferred to regard the fatal results as due to the work of some bacillus; others maintained its albuminoid origin; while others again regarded a combination of all these causes as the true solution of the question.

While works dealing rationally and scientifically with this theme were few formerly and far between, one important discovery has followed closely upon another during the last ten years, and, even at the moment of publishing this, the writer is anxiously scanning each new number of the various journals, magazines, and proceedings, for fear that the latest mail may bring some important information that might make it necessary to modify or even rewrite this account, lest it should become antiquated even before it reaches the hand of the reader.

Before giving a résumé of these late discoveries, the methods of work by which they have been obtained will be briefly discussed.

Attention is directed at the very outset to the fact that the poison of the various kinds of snakes (we speak only of that of the elapoid and viperoid snakes, as the poison of the opisthoglyph snakes has not yet been investigated in the same manner) differs a great deal both in external or physical qualities as well as in chemical composition, and that the poisoning occasioned by its injection often shows very marked symptomatic differences. Within certain limits these differences are only those of degree, and it will be possible in the following to make the statements somewhat general, though in the details there may be slighter deviations according to the kind of snake we have to deal with.

The first thing, of course, is to obtain the poison. The investigators prefer the fresh secretion, if it can be had, for although dried or kept in alcohol the venom is not made innocuous, yet even a slight modification of its properties is to be avoided if possible. A sufficient number of live snakes is therefore highly desirable (Weir Mitchell at one time had at least one hundred in his laboratory), for the quantity of the fluid which each snake yields at any one time is comparatively small.

The methods for obtaining the venom are somewhat various. To kill the snake in order to extract it from the glands directly is a waste of material well to be avoided. The process of allowing it to bite into a soft material from which it is afterwards extracted is open to the

objection that some of the fluid is lost, that it is unnecessarily brought into contact with substances which may affect its nature more or less, and that it is not obtained in a concentrated state, as it must be washed out with distilled water. Dr. Weir Mitchell, after having seized the snake by the neck with the tongs or loop, forced a saucer between the jaws, into which the enraged animal would then bite vigorously, leaving a quantity of the poison on the saucer. Prof. Kaufman having experienced that the snake often breaks its teeth on such a hard substance, or even refuses to bite, used a stick covered with rubber. The late Dr. C. S. Allen, of New York, for the same reasons covered the mouth of a wineglass or similar vessel with an animal membrane through which he induced the snake to strike the hollow teeth, the fluid being squirted into the glass. Dr. Paul Barringer, of the University of Virginia, has, it seems to me, improved upon this method by using several thicknesses of filtering paper, the object being to clean the fangs of possibly adhering saliva, and thus prevent the venom from coming in contact with foreign substances and the microbes inhabiting them.

The substance thus obtained is a more or less yellowish, exceptionally colorless, transparent, sticky fluid, without any appreciable smell or taste, easily soluble in water, insoluble in absolute alcohol or ether. If vigorously shaken it becomes frothy. Examined under the microscope, epithelial cells and other impurities are found, as well certain albuminoid bodies resembling micro-organisms, but they do not respond to the dye tests for bacteria, nor are they multiplied by cultures. Drs. Mitchell and Reichert have demonstrated the presence of bacteria (*l. c.* pp. 6–7), but their own researches, as well as those of others, also show that they form no constant or essential accompaniment.

Mitchell and Reichert (*l. c.* p. 137) injected large quantities of the pure micrococci from a sixth generation, in various manners, into rabbits, cats, pigeons, etc., but no signs of any lesions resembling those of venom poisoning were observed.

Drs. Wolfenden and Dawson Williams* endeavored to grow cobra venom in gelatine, "but without the slightest success;" Dr. A. Viaud-Grand-Marais† states that "bacteria and other protoorganisms are seen to make their appearance when the solutions of the venom commence to undergo alterations, but only then."

Fredet is said to have made similar observations, and Kaufmann‡ corroborates these statements from his own experiments.

Another essential point is, that even boiling, unless continued for a long time, does not altogether destroy the poisonous qualities of the fluid. Mitchell found that the rattlesnake poison suffers a gradual impairment of the toxicity of the venom increasing with the increase

* Journ. Physiol., Cambr., VII, 1886, p. 331.

† Dict. Encycl. Médec., Paris (3 ser.), IX, 1881, p. 388.

‡ Ven. Vip., 1889, p. 4; Vip. France, 1893, p. 23.

of temperature, but that it is still toxic even when boiled; Dr. Wall's experiments,* as quoted by Wolfenden, seem to show that cobra poison resists the heat even better, for it is stated that prolonged application of heat (for two hours) at a high temperature at last destroys the toxicity of cobra venom, and that a dilute solution is more easily destroyed by heating than a strong, such a toxic dilute solution being destroyed after heating at 106° C. for half an hour.

When exposed to the air, even for a short time, the fluid poison takes up bacteria, and putrefaction proceeds particularly rapid if the venom be diluted with water. Continued alteration of this kind finally appears to destroy its toxicity.

Excluded from the air, however, or preserved in pure alcohol or glycerine, the venom retains its properties for almost any length of time, as shown by the fact that a glycerine solution in the possession of Dr. Mitchell for twenty years was still toxic.

Dried and kept from atmospheric humidity it is equally permanent, twenty-two years not being able to alter it in the least. It is therefore advisable to handle the dried isolated fangs of the large venomous snakes with caution. It dries somewhat like a gum or varnish, and will crack and scale off in a similar manner.

In discussing the chemical characteristics of snake poison, it is hardly necessary at the present day to refer to the now thoroughly refuted theories of the crystalline nature of any of its active toxic constituents. The last attempt (that of A. Wynter Blyth) † to prove the poisonous quality of the cobra venom to be due to a certain "cobric acid" was effectually disposed of by Dr. R. Norris Wolfenden, ‡ and need not detain us here.

There are, on the other hand, still some physiologists who are not satisfied that the negative results obtained by Prof. Wolcott Gibbs at the request of Drs. Mitchell and Reichert in their search for alkaloids in the venom of the rattlesnake are absolute conclusive, in view of Dr. Armand Gautier's positive determination of leucomaïnes or alkaloids derived from living protoplasm in snake poison. In his much discussed article, "Sur les alcaloïdes dérivés de la destruction bactérienne ou physiologique des tissus animaux,"§ Gautier positively affirmed his assertion of 1881 (Bull. Ac. Méd., Paris (2 ser.), x, 1881, pp. 947–953, and discussion following, pp. 953–958) that from the venom of a *Trigonocephalus*, and particularly from that of the cobra, he had been able to extract a small quantity of matter belonging to the organic alkalis. From the cobra poison he prepared two new alkaloids, which, among

*Indian Snake Poisons, 1883 (pp. 120–124).

† The Poison of the Cobra de Capello. Analyst, I, London, 1877, pp. 204–207.

‡ On 'Cobric Acid,' a so-called constituent of cobra venom. Journ. Physiol., Cambridge, VII, 1886, pp. 365–370.

§ Bulletin de l'Académie de Médecine, Paris (2 ser.), XV, 1886, pp. 65–97: I part. Alcaloïdes bactériennes ou ptomaïnes; pp. 115–139: II part. Alcaloïdes physiologiques ou leucomaïnes.

other peculiarities, possessed the property of immediately precipitating Prussian blue when treated successively with ferrocyanide of potassium and the ferric salts. He expressly remarks, however, that these alkaloids do not constitute the most dangerous part of the venom, which he asserts is of a nitrogenous nature. They seem chiefly to stupify, but are not necessarily fatal. In the course of the discussion he further emphasized the fact that these leucomaïnes in the normal state of the tissues only occur in minimal proportions (*tom. cit.* p. 431).

Other careful investigations simultaneous with and later than those of Prof. Gibbs have fully substantiated the claim that the leucomaines play no rôle in the poisoning, and that, if present, they form no essential part of the venom. Dr. Wolfenden (*loc. cit.* p. 335) made examinations of cobra venom by the Stas-Otto method for ptomaine, or alkaloid, in three different instances, but did not succeed in finding the slightest trace of any such body. There was neither trace of fixed nor volatile alkaloid, the residues were noncrystalline and, moreover, nontoxic, and gave none of the alkaloidal test reactions.

Prof. Gautier, as I have already intimated, insisted that the toxic constituent of the venom is of a different nature. The researches of the last ten years have proved beyond a shadow of doubt their proteid nature, and that Bonaparte was correct when, in 1843, he referred to it as an albuminoid.

The achievements during the last decade in the study of the chemistry of snake venoms have been of such a nature, are so recent, and even now progressing, that the best way to record them is to treat them historically and chronologically.

The first progressive step was taken when, in 1883, Dr. S. Weir Mitchell and E. T. Reichert, of Philadelphia, laid before the National Academy a preliminary report on the results of studies, which, after a lapse of twenty years. Dr. Mitchell had resumed. He had in some way become convinced that the complexity of the symptoms in snake poisoning could not be the result of a single simple constituent, but that they might be explained by the assumption of a similarly complex nature of the albuminoid body, the crotaline, previously thought to be simple. Dr. Mitchell, in a later popular article,* has given a clear and interesting insight in the mental process which led to the important discovery and the laboratory processes by which it was demonstrated, from which we make the following abstracts:

When I first studied this strange poison I thought of it as a single albuminous body. As such it had always been regarded since it had been proved by Prince Bonaparte to belong to the albumens. When once I chanced to think that venom might be a complex fluid, holding in solution more than one poison, reasons for such a belief multiplied, and so excited my interest that, in 1882, with Prof. Reichert's aid, I began to put my theory to the sharp test of experiment. To prove in the outside laboratory what the inside mental laboratory has comfortably settled is not always easy, and many months of careful research were required before the answer

* Century Magazine, N. York, XXXVIII, Aug. 1889, pp. 503–514.

came to us. I will try to make clear our methods and results. When a little of the venom is placed in sufficient water it dissolves readily. If now we heat the solution a coagulation takes place, just such as happens when white of egg hardens on boiling. If by means of a filter we separate this substance, clotted by heat, it is found to be innocuous. The clear fluid which passes through the filter is, however, poisonous, but does not cause much *local* effect. As a whole the poison has been damaged by heat, presumably because one or more of its ingredients had been injured by heat. The next step is to learn if the substance made solid and inert by boiling can not be separated in some other way and in such a form as will leave it also poisonous.

All soluble substances are divisible into two classes, one of which will pass through an animal membrane into a current of pure water, and one of which will not. Those which can so pass are said to be dialysable, and the filter is known as a dialyser, and the process is called "dialysis." We disolve some of the poison in water and put it in an inverted funnel, the wide mouth of which, being covered with a thin animal membrane is placed in distilled water. Under these circumstances the water goes through the membrane, and dilutes the fluid above it and certain substances pass out to the water.

The matter which thus finds its way out to the water is said to be dialysable. When examined it proves to be poisonous—to be uncoagulable by heat, and to be the same as the matter left unaltered when we boil the diluted poison for a few moments. This substance resembles the albuminous matter which is formed when gastric juice digests white of egg, and as the material so obtained is called peptone, we name our product which passed through the dialyser to water *venom peptone*.

As the thinner water enters the dialyser and the peptone goes out within the vessel there falls down a white substance, which is easily redissolved if we add a little common salt. It falls out of solution because the salts belonging to venom and which keep the white matter dissolved are, like all saline substances, dialysable and pass out along with the peptone. This white precipitate has certain likenesses to the albuminous bodies known as globulin, and of which there are several kinds in our bodies. That which falls out of the solution of venom we named *venom globulin*.

The final results of Mitchell's and Reichert's investigations were embodied in a fine quarto volume published by the Smithsonian Institution in 1886 as one of its "Contributions to Knowledge" under the title "Researches upon the Venoms of Poisonous Serpents," to which we must refer the reader for details.

There are in those results, with regard to the chemical nature of the venom, two points, however, to which I will call particular attention as being of a fundamental nature, and which the reader must keep steadily in mind if he wishes to understand the present status of the question, viz, first that the crotalus poison, as well as the cobra venom, consists of several proteids, two of which are preponderating, although present in a varying degree. One of these, the *globulin*, is not dialysable; the other proteid, which passes through the membrane of the diaylser, Mitchell referred to the peptones, though possibly it belongs to another class, as will be seen later on.

The second point is that these two chief constituents are present in different proportions in the various poisons, the globulin occurring mostly in the crotalid snakes, but only in a minimal quantity in the cobra. This difference in the composition of the venoms corresponds markedly with the difference in the symptoms accompanying poisoning by the *Crotalidæ* (and the nearly related *Viperidæ*) on the one hand, and

by the *Najidæ* or cobras (and the nearly related *Elapidæ*) on the other, as will be shown further on.

Simultaneously with Mitchell and Reichert's report there appeared in England a couple of articles by Dr. R. Norris Wolfenden of a scarcely less import, he, however, having had the benefit of the preliminary report by his American precursors. He published them in the Cambridge Journal of Physiology under the common title "On the nature and action of the venom of poisonous snakes," the first one being a treatise on "The Venom of the Indian Cobra, *Naja tripudians*," the second "A Note upon the Venom of the Indian Viper, *Daboia russelii*."

Wolfenden's results are in the main the same as those of Mitchell and Reichert. Pursuing a different method of subdividing the proteids there are some differences in detail, which mean very little so far as the general result is concerned, but there is also one disagreement as to the nature and the nomenclature of the dialyzable portion. Mitchell referred it, as we have seen, to the peptones, but Wolfenden maintains that it can not possibly be a peptone since it is precipitated by acetic acid and potassic ferrocyanide. He, on the other hand, refers it to the albumoses, and in his analysis of the daboia poison he names it "*albumose* or *syntonin*." This is therefore practically the same as Mitchell's *venom peptone*.

Wolfenden found in the cobra an overwhelming quantity of the globulin, but scarcely any albumose; in the daboia, on the other hand besides the globulin, a certain quantity, proportions not given, of "albumose or syntonin," which seems to be more difficult to dialyze than the crotalus proteid of the same class. As will be seen, Mitchell's conclusions were amply and independently confirmed.

The very latest studies of the chemical nature of the venom are those of Dr. C. J. Martin and Mr. J. M'Garvie Smith, of Sydney, Australia, who have successfully investigated the poison of the Australian black snake, *Pseudechis porphyriacus*, a very dangerous snake related to the Indian cobra.* Their results corroborate in the main those of their predecessors, and in their endeavor to identify the various proteids which constitute the venom, they successfully separated three proteids, viz., "one an albumin, and the other two albumoses. The albumin is not virulent, but the two albumoses (corresponding to proto and hetero-albumoses of Kühne) are extremely poisonous. They each have the same physiological action and this is the same as that produced by the venom itself."

It is one of the great merits of Mitchell and Reichert's work that they undertook to test directly upon the venom the numerous chemical antidotes which from time to time have been suggested or from their known action on similar substances seemed to give promise of favorable results. It was found that many are worthless, that in fact only a few

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* Proc. Roy. Soc. U. S. Wales, Aug. 3, 1892, and Journal of Physiology, XV, 1893, (p. 380). See also W. D. Halliburton's paper on "Snake Poison" in Science Progress, II, Sep. 1894, pp. 1–9.

exert such an influence upon the venom as to make them available as *local* antidotes. We emphasize *local*, because from the very nature of the poison as an albuminoid and consequently chemically closely related to normal constituents of the blood, there can be no chemical antidote which after the introduction of the venom into the circulation would be able to destroy the poison without also destroying the blood itself.

I wish to call attention here to the fact that Mitchell repeatedly makes distinction between the poisoning resulting in death within a few hours and when it is slower in coming. He found that in the most rapid poisoning there is frequently nothing appreciable to the naked eye beyond the slight local lesion, or here and there minute capillary hemorrhages, when death has been delayed beyond a minute; while in examples of chronic poisoning, both the local and the systemic changes are enormously more extensive. This distinction between local and systemic changes is one of considerable importance, since the rational treatment of any given case hinges upon the full understanding of this point.

Only two years pass, and another very important contribution to our knowledge of the intricate question of snake poison was published, this time by a Russian, Dr. E. A. Feoktistow, the same whose work on the rattle of the rattlesnake we have already had the occasion to quote In 1888 he issued a doctor dissertation with the following title: Experimentelle Untersuchungen über Schlangengift,* based upon about 400 experiments with the fresh venom from about 200 specimens belonging to several species of vipers and *Crotalus durissus*. His researches cover to a great extent those of Mitchell and Reichert. In some cases the disagreement between the results of these eminent students is highly perplexing; for instance, in regard to the effect of the venom upon the blood and the blood vessels. The disagreement as to the causes of death as formulated by Mitchell and Reichert, on one hand, and Feoktistow on the other, also seems startling at first, for the former conclude that death occurs through paralysis of the respiratory centers, paralysis of the heart, hemorrhages in the medulla, or possibly through the inability of the profoundly altered red corpuscles to perform their functions, and they positively assert that the direct action of the venom upon the nervous system, save as concerns the paralysis of the respiratory centers, is of but little importance, while Feoktistow with equal positiveness concludes that the snake venom is a nerve poison *par excellence*, which paralyzes the vaso-motor center, and in large doses the respiratory center as well. It is impossible for us here to carry out a comparative analysis of the two works, but I think it will be found that the disagreement between these authors is more apparent than real, and that it consists more in the interpretation of

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* St. Petersburg, 8vo., 47 pp.; a preliminary article in Mém. Ac. Sc. St.-Pétersb. (7e, sér.) XXXVI, No. 4, 22 pp., under title: Eine Vorläufige Mittheilung über die Wirkung des Schlangengiftes auf den thierischen Organismus.

the phenomena than in the results of the experiments themselves. But it would be a thankful task for an experienced physiologist to correlate all the facts, to eliminate possible errors, to reexperiment where there may be doubt as to the facts, and to weigh the evidence impartially for and against the various explanations. His work would not have to be confined to the works already mentioned, for the very next year there appeared another independent treatise of considerable importance.

In 1889 the French Academy of Medicine, in Paris, awarded the Orfila prize for 1888 to M. Kaufmann, professor of physiology at the veterinary school at Alfort, in recognition of his studies of the venom of the common viper of France, *Vipera aspis*.* Kaufmann's work is for the greater part a study of the action of the poison of the viper upon the nerves, the circulation, and the tissues, and of certain chemical antidotes upon the venom. It corroborates that of his predecessors, and shows the similarity of action of the viper venom to the crotalus venom, but it also contains several valuable new observations and new discoveries.

I have said that Mitchell has already called attention to the difference between the rapid and slow poisoning. Feoktistow made similar observations, but Kaufmann has emphasized it still more, and in part based his study upon this difference. His experiments, to a greater extent than his predecessors', were separately directed upon ascertaining the results of the injection of the venom directly into the circulation and those following only its hypodermic application to the tissues. The results deserve a closer examination here.

Injected directly into the veins of the animals experimented upon, the venom produces its effects with almost lightning rapidity, consisting in nervous, circulatory, respiratory, and digestive disturbances. The nervous disturbances consist of a primary excitation of very short duration, followed by a drowsiness, which lasts until death; the intellectual faculties are not impaired for a long while, but the general sensibility, as well as the voluntary and reflex movements, are rapidly affected. The circulatory disturbances consist in an enormous lowering of the arterial tension, due to a considerable vascular dilatation, principally in the abdominal digestive viscera; in a considerable acceleration of the pulse, and in a very great feebleness of the blood waves propelled by the heart. The respiration and calorification do not undergo profound alterations, only a slight diminution of their activity being observed. The conclusion is reached that the death which follows the introduction of the venom into the circulation must be attributed to gastro-intestinal apoplexy and the stupefying action exercised directly upon the nervous system. This is in confirmation of Feoktistow's views.

The hypodermic injections produce both general systemic effects identical with the above, due to the absorption of the poison into the

* Du venin de la vipère. Mém. Acad. Méd., XXXVI, 1889, and separate.

circulation, and local effects which develop at the point of injection and in the adjoining tissues. These local lesions consist in a more or less intense swelling, and in a purple or black discoloration produced by extravasation of blood and serum in the tissues affected by the venom. The death, which is due to the direct absorption of the venom, arrives very rapidly, and the characteristic internal hemorrhages are observed; the death, however, which is the consequence of the infection of local origin is slower, and the ordinary internal lesions are not found, but, on the contrary, considerable local alterations. The danger from the injection varies with the part of the body inoculated; thus injections of venom made on the inner side of the thighs or on the nose are very dangerous; those practiced on the side of the thorax muscles less so. The micro-organisms accompanying the local lesions are only accidental and secondary productions; they find excellent conditions for their propagation and multiplication in the altered or mortified tissue, but inoculated into healthy animals they do not produce the specific effects of the venom. After the injection under the skin, the poison is slowly diffused in the adjoining tissues and determines their progressive alteration without itself being altered in any way, for the venom can be traced in its full activity in the local lesions, and serum taken from the altered tissues, if injected into healthy animals, develops the ordinary effects of the venom; this serum, consequently, contains a certain quantity of active venom. On the other hand, venom does not accumulate in an appreciable quantity neither in the liver, the kidneys, nor the nervous centers, as serum taken from these tissues has remained inactive in animals inoculated with it.

Mitchell and Reichert had confirmed the destructive action of certain chemicals upon the venom and discovered others of similar action, notably permanganate of potassium, ferric chloride, iodine and bromine. To these Kaufmann adds chromic acid, which he highly recommends as a remedy for the local lesions.

The fact that chromic acid in a solution of 1 to 100 is one of the reagents which produces the greatest precipitate in the venom, besides being an energetic oxidizer, led Prof. Kaufmann to institute a series of very interesting experiments with it, which only lack of space prevents me from reproducing here in their entirety. Suffice it to say that they prove conclusively the potent and beneficent action of the chromic acid, not only when it is injected mixed with the venom, but also when introduced some time after the poisoning. The last experiment of the series (No. XXXV) is very instructive. Four dogs of about equal size were inoculated on the inner side of the thigh with two drops of fresh viper venom obtained immediately before the injection. One was left without further treatment, the others had injected in the puncture, five minutes after, respectively 1:100 solutions of chromic acid, permanganate of potassium, and bichoride of mercury. The following morning all showed local congestions, and in the evening of that day the dog

which had received no remediary injection died. On the third day, in the one treated with chromic acid the local congestion was red, in the other two œdematous and blackish. On the fourth day the reddening had almost disappeared in the former and no ulceration was to be observed; in the dog treated with permanganate the discoloration had also nearly disappeared, but there was a large ulcer, while the one treated with bichloride of mercury had not even improved so much. They afterwards all fully recovered. Kaufmann sums up the result of this experiment as follows: This experiment demonstrates that the three agents employed have preserved the animals from death; the bichloride has the inconvenience of producing a caustic action, forming a scar and a wound long to heal; the permanganate, although less destructive, also leaves a wound which takes long time in scarifying, while the chromic acid most completely checked the action of venom without occasioning any cauterization or ulceration.

The point essentially proved by the above experiment is the relative superiority of the chromic acid over the permanganate and the bichloride of mercury.

Three years later, Dr. Albert Calmette, surgeon of the first class of the colonial medical staff and director of the bacteriological institute at Saigon, Cochin China, published a similar series of experiments* with a solution of chloride of gold, upon the venom of the cobra. He claims to have secured quite a success in saving the animals experimented upon, the experiments being conducted very much like those of Kaufmann, by injection of the venom mixed with the chemical, and by injecting them separately, the latter as late as five minutes after the former. Very little can be gathered from his experiments as to the efficacy of the chloride of gold in counteracting the local disturbances as compared with that of chromic acid, because of the slight local effects of the cobra venom. Whether the chloride of gold in this respect is the equal of the chromic acid is therefore doubtful, although from the facts that it forms an insoluble precipitate with the venom and that its cauterizing effect is but slight, it may probably be inferred that there is but little difference between them.

Dr. Calmette has recently † recommended a solution (1:11) of chloride of lime as superior to the chloride of gold, it being effective up to fifty minutes with rabbits which would otherwise have died in two hours.

Unfortunately for Dr. Calmette's claim for the efficacy of chloride of gold, an English physiologist,‡ undertook a series of similar experiments with an entirely different result. From his criticism it would appear as if the whole treatment of local neutralization of the venom

* Étude expérimentale du venin de Naja tripudians, etc. Ann. de l'Inst. Pasteur, Paris, VI, 1892, pp. 160–183; also, Arch de Méd. Nav., Paris, LVIII, 1892 (pp. 161–190); see also Brit. Med. Jour., Weekly Epitome, 1892, April 23 (p. 67).

† See McClure's Magazine, III, October, 1894, p. 466.

‡ Chloride of Gold as a Remedy for Cobra Poison, by A. A. Kanthack. Lancet, London, 1892, I, pp. 1296–1297.

by injection of a chemical destroyer at the wound is chimerical, but such a conclusion, it seems to me, would be premature to say the least. It is true that the introduction and non-efficacy of the venom mixed with the chemical proves nothing as being practically no venom; it is also true that the introduction of the chemical five minutes after the bite would be of but little practical use if five minutes were the extreme limit for its beneficial action. It is also undoubtedly true that even within this time it is not always capable of, alone and unassisted, to save the life of the patient. On the other hand, it must not be forgotten that the above experiments had been chiefly theoretical, and that no means were taken to assist the remedy experimented with. It is rather singular that the experimenters should not have extended their experiments somewhat, and it is particularly surprising that those testing the efficacy of the local treatment should not have introduced the use of ligatures to a greater extent. By thus confining the action of the poison to the neighborhood of the point of inoculation the experimenter would probably have been able to extend the period within which the chemical agent showed itself beneficent considerably beyond the five minutes. I think this is a point worthy of consideration by those contemplating future experiments with local chemical remedies.

After the important discoveries of Mitchell and Reichert as to the multiple chemical composition of the snake poisons, it was but natural that the attention of the searchers for remedies was principally drawn in the direction of looking for local chemical destroyers. It was also natural that these researches should prevail in those countries in which the crotalids and the vipers predominate, because of the local destructiveness of the poison of these snakes. But the other side was, fortunately, not lost sight of, and the search for remedies to counteract the poison after it has reached the circulation, was naturally carried on most vigorously in the home of the najid and elapid snakes, in India and Australia.

Mitchell had already pointed out the hopelessness of finding a chemical which, introduced into the veins, would be able to destroy the poison without also destroying the blood. The only rational line of research would be to discover such remedies as would, to use Mitchell's words, "oppose the actions of venom upon the most vulnerable parts of the system," or, as he calls them, "physiological antagonists." It will be remembered that Mitchell and Reichert came to the conclusion that "there can be no question, however, that the respiratory centers are the parts of the system most vulnerable to venom, and that death is most commonly due to their paralysis." Although, according to them, paralysis of the heart generally only plays a secondary rôle in the case of snake poisoning, yet the cardiac power is sensibly enfeebled, especially in the early stage. The kind of remedies to be looked for would

consequently be such as will stimulate the vital functions of respiration and circulation.

The remedy which to them seemed to hold forth the greatest promise of success was alcohol, a stimulant the effects of which are well known; which is, moreover, usually readily at hand, and which has been extensively tried for the purpose. It has been used both by the layman and the practitioner, often with apparent success, and its application has undoubtedly saved many a life. On the other hand, reports are numerous of patients having died which were under the influence of liquor when bitten, or to whom whisky was afterwards administered. But it is safe to say that in most of these cases the alcohol had been taken in excess so as to depress instead of stimulate the vital functions. It can not be emphasized too much, or too often, that intoxication, so far from helping the cure, helps the poison, and that persons having been made intoxicated beyond excitement, when under treatment for snake bite, and yet recovered, have so recovered not from the treatment but in spite of it. It should also be remembered that the alcohol has no beneficent direct action upon the venom; on the contrary, applied locally or intravenously, it seems to add to the virulence of the poison.

Notwithstanding all that has been written about the utter uselessness of ammonia, we see still occasionally in medical literature reports from physicians who have obtained cures in spite of its application. Injected directly, it is worse than useless. It should not at this late date be necessary to fill pages in order to emphasize this fact, which has been conclusively demonstrated by all rational experiments from the time of Fontana to that of Mitchell and the other physiologists of to-day. Internally, as a stimulant, it has also been shown to be much inferior to alcohol. The radical defect of ammonia in severe cases consists in the fact that it increases the arterial pressure, thus aiding the poison in producing the internal hemorrhages.

The remedy which has come prominently to the front during the last five years, however, and which really seems to come up to all reasonable expectation, is a poison scarcely less terrible than the snake venom itself, viz, *strychnine*. The theory upon which the application of this drug has been based is, on the one hand, that the snake poison acts as a specific nerve poison, depressing and more or less suspending the function of the motor nerve centers throughout the body without interfering with the structure of the nerve cells, and, on the other, that the physiological action of strychnine upon the same organs is diametrically opposed to the action of the venom, or, in brief, that "strychnine is the exact antithesis of snake poison in its action." To use the words of the main advocate of strychnine as an antidote:

Whilst snake poison turns off the motor batteries and reduces the volume and force of motor-nerve currents, strychnine, when following it as an antidote, turns them on again, acting with the unerring certainty of a chemical test, *if administered in sufficient quantity*. Purely physiological in its action, it neutralizes the effects of the

snake poison, and announces, by unmistakable symptoms, when it has accomplished this task, and would, if continued, become a poison itself. Previous to this announcement its poisonous action is completely neutralized by the snake poison, and the latter would therefore be equally as efficacious in strychnine poisoning as strychnine is in snake poisoning.*

I am not aware that this test has been applied, but I may here call attention to the fact that Dr. A. O. Ameden, of Glens Falls, N. Y., by a similar train of reasoning, was led to apply rattlesnake poison to a case of tetanus apparently with most signal success. †

It seems that the great discovery of strychnine as the antidote par excellence was barely missed by Dr. Louis Lanszweert, who in 1871 published a short article, "Arseniate of Strychnia: New Antidote to the Poison of Snakes," ‡ in which he somewhat vaguely refers to five cases successfully treated by him in San Francisco, as well as to some equally successful experiments made by him in Paris upon rabbits. It is evident that he regarded the arsenic as the antidote, and it is not at all clear why he added the strychnine, except that by this addition he obtained "a more readily soluble substance than arsenious acid." It is now well known that arsenic is no specific antidote, and it seems almost certain that the success of Dr. Lanszweert's treatment was due to the strychnine. From what I have shown above, Dr. Ameden, in 1883, came also dangerously near making the same discovery.

It has recently been claimed that Dr. John Shortt, of India, as early as 1868 experimented with strychnine, but that it was given up on account of the failure of experiments upon animals. Dr. Shortt's efforts may possibly have been published in the unprofessional local press; but in 1868 as well as in 1870 he recommended liquor potassæ as an antidote, without mentioning strychnine. The honor of the discovery can, therefore, not be claimed for him.

This was reserved, however, to a then obscure Australian practitioner, Dr. A. Mueller, of Yackandandah, Victoria, who in 1888, in the most positive manner, claimed that he had practically proved strychnine to be the specific antidote by the success of his cures, and to have demonstrated the scientific correctness of the theory by accounting satisfactorily for all the phenomena observable in connection with the subject.

Dr. Mueller's discovery, which was published in a series of articles in the Australasian Medical Gazette, in Sydney,§ at once started a vigorous, sometimes even acrimonious, discussion in Australia, and the

* On Snake Poison, by A. Mueller, 1893, p. 42.

† Serpent Venom as a Remedial Agent in Tetanus. Medic. News, Phila., 1883, XLIII, p. 339. Also, Crotaline as a Remedy in Tetanus. Med. and Surg. Rep., Phila., 1883, XLIX (p. 642). Also, Rattlesnake Venom in a Case of Tetanus. Albany Med. Ann., 1885, VI (p. 91).

‡ Pacif. Med. and Surg. Journ., San Francisco, Aug. 1871 (n. s.), V. pp. 108–115.

§ On the Pathology and Cure of Snake Bite. Australas. Med. Gaz., 1888, 1889, VIII, pp. 41–42 (I); pp. 68–69 (II); pp. 124–126 (III); pp. 179–182 (IV); pp. 209–210 (V).

strychnine was most earnestly tested and enthusiastically indorsed by Dr. Mueller's followers, while his antagonists of the old school went to the other extreme of denouncing the subcutaneous injection of the drug in snake venom cases as being of equal value to so much water. The medical journals of the colonies from that time on are full of the controversy, which soon spread to India.

The opposition gleefully recorded several cases of death in spite of the administration of strychnine. In addition they clamored for a series of experiments upon animals by which the theory could be "scientifically" tested, at the same time pointing out that the experiments which had so far been undertaken did not seem to support Dr. Mueller's contention.

These criticisms Dr. Mueller has met by explaining in an apparently satisfactory manner why in the fatal cases reported the treatment had failed, it being mostly due to the fact that not enough strychnine had been administered. As to the experiments on animals, it was contended that the physiological effects of strychnine upon man and the various kind of test animals is so different that no safe conclusions can be drawn, and that, moreover, the numerous tests afforded by the cases of human beings having been bitten and saved from death by the administration of the strychnine is the best possible proof of its efficiency.

From an article recently published (Australas. Med. Gaz., Sydney, XII, December 15, 1893, pp. 401–403) it will be seen that the opposition to the strychnine treatment is on the wane and that the Governments of Australia and India are alive to the importance of Dr. Mueller's discovery. The latter, in his recent book,* furthermore states that he knows from good authority that Sir Joseph Fayer, the president of the medical board at the India office, the celebrated authority on snake poison, and author of the monumental work "The Thanatophidia of India," has recommended to the English Government the adoption of the strychnine treatment of snake bite in India. It is but fair in a case like this to render the results of Dr. Mueller's discovery in his own words. Hence the following quotations from his book, which I have deemed it essential, should be as full as practicable, especially since his work has so far received but little attention in this country:

> It is self-evident from preceding statements that in the treatment of snake bite with strychnine the ordinary doses must be greatly exceeded, and that its administration must be continued, even if the total quantity injected within an hour or two amounts to what in the absence of snake poison would be a dangerous, if not a fatal, dose. Timidity in handling the drug is fraught with far more danger than a bold and fearless use of it. The few failures among its numerous successes recorded during the last four years in Australia were nearly all traceable to the antidote not having been injected in sufficient quantity. Even slight tetanic convulsions, which were noticed in a few cases, invariably passed off quickly. It should be borne in mind that of the two poisons warring with each other, that of the snake is by far

*Snake Poison and its Action. Sydney, 1893, p. 70.

the most insidious and dangerous one, more especially in its effects on the vaso-motor centers. The latter are wrought very insidiously and where they predominate require the most energetic use of the antidote; for whilst the timid practitioner, after injecting as much strychnine as he deems safe, stands idly by waiting for its effects, the snake virus, not checked by a sufficient quantity of it, continues its baneful work, drawing the blood mass into the paralyzed abdominal veins, and finally, by arrested heart action, bringing on sudden collapse. In such cases even some tetanic convulsions are of little danger and may actually be necessary to overcome the paralysis of the splanchnicus and with it that of the other vaso-motor centers.

Whilst then it must be laid down as a principle that the antidote should be administered freely and without regard to the quantity that may be required to develop symptoms of its own physiological action, the doses in which it is injected and the intervals between them must be left to the practitioner's judgment, as they depend in every case on the quantity of snake poison absorbed, the time elapsed since its inception and the corresponding greater or lesser urgency of the symptoms. If the latter denote a large dose to have been imparted and it has been in the system for hours, delay is dangerous and nothing less than 16 minims of liq. strychniæ P. B., in very urgent cases even 20 to 25 minims, should be injected to any person over 15 years of age. Even children may require these large doses, as they are determined by the quantity of the poison they have to counteract and are kept in check by it. The action of the antidote is so prompt and decisive that not more than fifteen to twenty minutes need to elapse after the first injection before further measures can be decided on. If the poisoning symptoms show no abatement by that time, a second injection of the same strength should be made promptly, and unless after it a decided improvement is preceptible, a third one after the same interval. As the action of strychnine when applied as antidote is not cumulative, no fear need to be entertained of violent effects breaking out after these doses repeated at short intervals. * * *

If under the influence of these large doses the symptoms abate, or if the latter are comparatively mild from the first, smaller doses of strychnine should be injected, say from one-fifteenth to one-tenth of a grain, but under all circumstances the rule that distinct strychnia symptoms must be produced before the injections are discontinued should never be departed from. This rule is a perfectly safe one for its observance entails no danger, a few muscular spasms or even slight tetanic convulsions being easily subdued and harmless as compared with that most insidious condition exemplified in case No. 1, cited below, the first one treated with strychnine by the writer, who, having no experience in the treatment, did not administer quite enough strychnine. The patient, after apparently recovering from a moribund condition and being able to walk and even to mount a horse, remained partly under the influences of the poison and succumbed to it during sleep, when, according to subsequent experience, one more injection would have saved him.

The tendency to relapses is always great when much snake poison has been absorbed. Apparently yielding to the antidote for a time, the insidious venom, after a shorter or longer interval during which it appears to have been conquered, all at once reasserts its presence, and has to be met by such fresh injections, regardless of the quantity of strychnine previously administered, but the amount required in most relapses is not a large one.

In speaking of the applicability of the treatment to bites of snakes with longer fangs and more powerful venom than those of Australia, he concludes as follows:

In those cases only where the long fangs of these snakes perforate into a vein and a large quantity of venom injected into the blood stream overpowers the nerve centers so as make death imminent, if not almost instantaneous, the subcutaneous

injections may be found of little use. Here intravenous injections of half a grain and even 1 grain doses would appear to be indicated, and might yet fan the flame of life afresh, even when respiration and pulse at wrist have already ceased. We have seen both these functions extinct in Australia and restored by comparatively small doses of the antidote, and can see no reason why a more energetic use of it should not restore them in India

Dr. Mueller next enumerates in detail 50 cases, only 2 from his own practice, some of them very remarkable and several, as it seems, quite conclusive, but as none of these cases were caused by snakes directly related to our American poisonous serpents. except to the *Elapidæ*, it is not thought necessary to reprint any of them here. The first case reported is the one alluded to above, the first case treated by Dr. Mueller with strychnine. The case ended fatally.

The death of the unfortunate lad, however, has saved some lives since. It taught the writer the lesson never to trust to the apparent success of the antidote until it shows distinct signs of its own physiological action, and even then to watch his patients carefully for the first twenty-four hours, and let them sleep for short periods only.

The cases from India reported by Dr. Banerjee, also reprinted in the book, have been assailed as unreliable, but since the publication of the book others have been recorded in the Indian Medical Gazette, for 1893, and reprinted in the Australasian Medical Gazette (see, for instance, two in Vol. XIII, January 15, 1894), which seem to indicate a success for the treatment in India as great as in Australia.

An entire chapter is devoted to the unsuccessful cases, which are analyzed and explained. The last one Dr. Mueller finds to convey a new lesson even to him, as he draws from it the conclusion that the antidote can only be relied on within the first twenty-four hours after the bite.

It can not for a moment be supposed that the discovery of the strychnine treatment will be accepted as the final settlement of the question of a physiological antidote. As a matter of fact, our knowledge of the physiological action of the various venoms is as yet but imperfect, and the physiological properties of many of the drugs which may be called to play a rôle are not better known. Experiments are still carried on, but as no definite results have as yet been obtained we shall only mention them very briefly.

In 1888, Dr. H. C. Yarrow published a series of articles in Forest and Stream concerning "Snake bite and its Antidote."* In the introduction he gives an interesting historical sketch of the search for antidotes, and then submits in detail a series of experiments of his own, among which I wish to call special attention to those with *jaborandi*, or its alkaloids pilocarpine and jaborine, the use of which was first

*Forest and Stream, N. Y., XXX; Pt. I, May 10, 1888, p. 307; Pt. II, May 17, pp. 327, 328; Pt. III, May 24, pp. 349, 350, and May 31, pp. 369, 370; Pt. IV, June 7, pp. 386–388; Chapters II and III also reprinted in Albany Medical Annals, 1888, IX, pp. 201–21?.

introduced, it seems, by the French physician, Dr. Josso.* Rabbits and fowls were inoculated with crotalus poison and treated with extr. jaborandi, both hypodermically and in the stomach. It appears that the rabbits recovered even from a fourfold lethal dose of the venom, while in the fowls the effect of the antidote was less marked, as it was only capable of prolonging but not saving life.

Another drug which it might possibly pay to experiment with is *strophanthus*, as suggested by Dr. T. L. Bancroft, of Australia. In short, there is yet a wide field open for the investigators.

The beneficial effects of the jaborandi are probably to be ascribed to the influence of this drug both upon the skin and the liver, and this fact opens up another question which must be taken into consideration before we conclude this chapter, viz, the question as to the way in which the poison is eliminated by the system; for it is plain from all that we now know of the physiology of the case that when the poison has once entered into the circulation all that can be done in this direction is to counteract its immediate effect upon the nerve centers, thus prolonging life and enabling the system to throw off the poison. Any remedy that would assist in doing so would be a distinct help. But in order to find such a remedy it is necessary to know exactly how the poison is finally got rid of. Unfortunately, this is a point upon which no conclusive studies have been made. As already mentioned, experiments have been made which go to show the presence of the venom in the liver, kidneys, etc., although in but small quantity. I am not aware that there has been made any extended experiments to ascertain the presence of the poison in the perspiration, a point well worth investigation in view of the fact that there are cases of severe systemic poisoning which have been reported † cured simply by means of profuse perspiration. Inoculation of urine of the bitten subject has been occasionally undertaken to test the presence of venom, and fatal results have been reported, but the experiments have not been conducted in such a way as to satisfy us that death was not due to the ptomaines contained in the urine.

However, Feoktistow found, in addition, gross anatomical changes in the kidneys of poisoned cats, and Dr. Mueller has recently ‡ called attention to the probability that the snake poison is eliminated through the kidneys.

Quite recently Dr. Konrad Alt, of Germany, in a paper read before the Natural History Society of Halle on the Saale, on July 23, 1892, § has demonstrated that a portion of the venom, at least, is eliminated by

*Gaz. Hebdom. de Médec. et Chir., Paris (2 ser.), 1882, XIX (p. 835).

† For instance: W. H. Wooster, New Treatment for Snake Bite and other Poisons. Science, XX, Nov. 4, 1892, pp. 255, 256.

‡ On Hæmaturia in Snakebite Poisoning. Australas. Med. Gaz., Sydney, XII, Aug. 15, 1893, pp. 247–249.

§ Untersuchungen über die Ausscheidung des Schlangengiftes durch den Magen. Münch. Medic. Wochenschr., XXXIX, Oct. 11, 1892, pp. 724–728.

the stomach. Two sets of experiments were made upon dogs. In the one set the stomach was washed out carefully, the result being that the animals so treated showed a distinctly less degree of poisoning than the control animals. In the other set, the contents of the stomach with proper precautions were inoculated into other dogs, the result being symptoms of poisoning identical with those of the control animals. Moreover, the presence of the unaltered venom was demonstrated by chemical tests.

The conclusion seems justified that a washing out of the patient's stomach ought to be part of the treatment of a case of snake bite.

This entire question seems a promising field for future investigation, which we earnestly recommend to physiologists having the opportunity and wishing to advance our knowledge of snake poison and its treatment.

TREATMENT.

It is not for the present writer to recommend any one special treatment of cases of snake-bite poisoning; but he is willing to state what would seem to be a rational treatment, in view of our present knowledge of the subject. He will, however, confine himself to such cases as may arise from poisoning by snakes occurring in this country only.

Evidently the first thing to ascertain is whether the case is really that of a bite by a poisonous snake, leaving here out of consideration the *opisthoglyphs*, the bite of which probably is too rare and too insignificant to need special mention. If consisting of one or of two isolated punctures, the wound is almost certain to be caused by a poisonous bite, and the distance between the two punctures will usually give a clew to the size of the snake and consequently to the presumable degree of the poisoning. If the snake or its head are secured, the identification may be comparatively easy, as all our poisonous snakes, with the exception of the *Elaps*, or harlequin snake, of the Southern and Southwestern States, are readily recognized by the pit between the eye and the nostril, as before stated (p. 365, fig. 9). The characters of the *Elaps* have also been given in this work (p. 356, figs. 5, 7, 8), and no difficulty should be found in making a correct identification. As will be plain from what has been said above concerning the difference in the action of the crotalid and the elapid snakes, this distinction may be of some importance in selecting the correct treatment.

In very severe acute cases, in which the venom has been injected directly into the circulation, no matter by what kind of snake, the chances for recovery are very slight indeed. The only chance in such cases seems to be to stimulate the nervous centers as speedily as possible, the best known means to this end being injection of large doses of strychnine, if necessary, intravenously, until tetanic effects are obtained and the patient roused from the coma which has probably seized him. This result obtained, other systematic or local remedies, as the case may require, can then be applied.

A similar treatment also seems advisable in such cases of slow poisoning in which the patient has already reached a stage of collapse, or coma, before assistance can be rendered, provided not more than twenty four hours have elapsed since the bite was inflicted, in which case injections of strychnine seem inapplicable.

If in case of slow poisoning help can be administered very soon after the infliction of the wound and the venom has been localized by ligatures and minimized by incision of the wound, sucking, or, better, cupping of the blood, the treatment next to be applied depends upon whether the offending snake is a Pit Viper (Crotalid) or an *Elaps*, for if it was a rattlesnake, a copperhead, or a water moccasin, attention should at once be directed to the local lesion, unless the state of the patient imperatively demands an immediate stimulant, in which case *small* doses of alcohol may be useful. Apparently the best treatment of the local lesion is an 1 to 100 solution of chromic acid injected into the incised wound, the punctures of the fangs, and into the surrounding swelling, as quickly as the circumstances will allow, since the success of this treatment depends upon the chemical reaching and destroying the venom before it is absorbed into the circulation. Kneading of the tissues surrounding the wound in order to bring the venom and chemical in close contact may be useful. If chromic acid is not at hand, chloride of gold, permanganate of potassa, etc., may be substituted.

There does not seem to be any necessity for amputation in a case where hypodermic injection of any of these chemicals can be applied. It can only be recommended in such extreme cases in which these remedies are not to be had, and the danger great. But even in this case the amputation must follow quickly or not at all.

The local lesion having been attended to, the general systemic treatment may commence, as by this time the venom has probably already entered the circulation, it being necessary occasionally to loosen the ligatures for a moment to prevent mortification. Alcohol in small doses and washing out of the stomach may now be in order, as well as the administration of sudorific and diuretic remedies, preferably extract of jaborandi. Hypodermic injections of 15 to 20 minims of liqu. strychniæ repeated every twenty minutes until slight tetanic spasms appear, seem to be warranted. Constant watching for relapses and attention to the local lesion will do the rest.

The action of the venom of the elapid snakes being so much more rapid and the local changes so insignificant as not to cause any great alarm, the chances are that when the patient asks for help and treatment the venom has already entered the circulation, and that attempt to destroy any appreciable quantity of the poison in the wound would be futile. However, whenever possible this should not be neglected. The usual first treatment would nevertheless be general, viz, the administration of stimulants, sudorifics and diuretics as instanced above, since the danger from a quick paralysis of the nerve centers is so much greater in these cases.

It may be well to emphasize here, that in the case of children the amount of the antidotal remedy to be administered must not be judged by the age of the child, but by the amount of venom to be counteracted as well as by the character of the snake, and it is worth remembering in this connection—besides the different action of the crotalid and the elapid snakes—that the degree of danger chiefly depends upon the size of the snake; that of our pit vipers the rattlesnake is the most dangerous, the copperhead less so, and the water moccasin the least so, although in itself not to be trifled with.

As for the preliminary treatment before medical assistance can be obtained or rational remedies applied, but little can be added to the old methods employed. The first thing to be done is to tie a strong ligature or two, a string or a handkerchief, between the wound and the heart, whenever practicable; next, cutting deeply into the punctures so as to make the blood flow freely; sucking out of the blood from the wound, a procedure perfectly harmless, unless the person doing it has an open wound in the mouth; next, careful loosening of the ligature so as to admit a small quantity of fresh blood to the ligated member in order to prevent mortification; next, administration of a stimulant; if at hand, small doses of an alcoholic liquor being given internally at frequent intervals; if alcohol is not at hand, and a stimulant appears imperative, a small dose of ammonia might be given, but *only* very shortly after the bite, not on a later stage when it will certainly do harm, at least in cases of poisoning by rattlesnake, copperhead, or water moccasin; if the patient has to wait for the arrival of a doctor, now is the time to try all reliable means to produce a profuse perspiration.

There may occasionally be such extreme cases in which amputation and cauterization by heat or otherwise would be the only available remedies, but as a rule such barbaric treatment need not be resorted to, and in most cases would probably be a cure worse than the disease.

There has been placed on the market several specially constructed contrivances for use in cases of snake bite, to which I wish to call attention.

A cupping instrument specially constructed for snake bite so as to be easily applicable to small surfaces or the extremities was made several years ago by William Hume, instrument maker, Lothian street, street, Edinburgh, Scotland, at a price of 10*s.* 6*d.*

In France, MM. Pelliot & Delon, 26 Rue du Roi-de-Sicile, Paris, at the instance of Prof. Kaufmann, have arranged a pocket case containing hypodermic syringe, chemicals, directions for use, etc., for the local treatment by chromic acid. Price, 6 francs.

Kaufmann's own directions for the injection of this fluid are as follows:

Two or three drops of an aqueous solution (1 to 100) of chromic acid or permanganate of potash are injected with a Pravaz syringe exactly into the puncture of each fang. It is necessary to let the

liquid penetrate into the tissues to the same depth as the venom; the injection must, therefore, be more or less deep according to the size of the snake. To make absolutely sure, three or four more similar injections are made a little distance around the point bitten.

If, at the time of treatment, the swelling has already obtained a certain size it may be necessary to make injections into various points of the tumor. After the injections the part is pressed gently with the hand so as to distribute the injected fluid in all directions and facilitate its mixture with the venom. Next, some punctures are made with the point of a knife. Usually a rather large quantity of yellowish serosity flows from the wound, mixed with a part of the injected fluid. In order to facilitate this discharge the swelling should be kneeded repeatedly with the hand. Then the surface should be washed with the permanganate or the chromic solution, and a small piece of lint soaked with one or the other of these liquids applied. If, after some time, the swelling continues to grow, additional injections into the parts must be made as well as punctures. With this treatment the tissues preserve their vitality; the skin does not turn black but remains red. The microbes are destroyed by the injected agents, which act as antiseptics as well as antidotes.

For the strychnine treatment the Australians have also constructed a pocket case containing patent poison sucker, hypodermic syringe with two needles, glass mortar and pestle, two tubes of strychnine tabloids, and directions for use. The manufacturer is L. Bruck, 13 Castlereagh street, Sydney, and it sells for £1.

It seems as if a combination of these two cases would be the thing for this country, and ought to be of great service not only to physicians residing in those parts of the States in which poisoning by snake bite is not unusual, but also to such persons who from their occupation are particularly exposed to dangers of this kind.

PREVENTIVE INOCULATION—THE IMMUNITY OF SNAKES AGAINST SNAKE VENOM.

It has been noticed from time to time by various experimenters that animals which had recovered from snake-venom injections showed a certain amount of resistance afterwards, so as to make them useless for future experiments. It naturally suggested itself to investigators that by continued inoculation of small doses of the pure or modified venom, immunity from the poison, even in otherwise fatal doses, might finally be obtained.

Such a preventive inoculation, although of doubtful use in this country, with its comparatively small number of fatalities from snake bites, might be highly beneficial in India and Australia, or to travelers or others in tropical countries, who might be specially exposed to such dangers.

As early as 1887 Prof. Henry Sewall, of the University of Michigan,

undertook and reported* upon a series of experiments with massasauga venom on pigeons. The conclusions drawn were that repeated inoculation with sublethal doses produced a continually increasing resistance toward the injurious effects of the poison without apparent influence on the general health of the animals. It was also shown, however, that the efficiency of resistance against the venom gradually fails in absence of fresh inoculation, although at least one of the pigeons retained its immunity over an interval of five months.

There is another class of observations which have a certain bearing on this question.

It has been long known, although occasionally doubted or contradicted, that the poisonous snakes are proof against their own venom. Big doses of snake venom have repeatedly been inoculated into the bodies of the producers themselves absolutely without effect. The current stories of "suicides" of rattlesnakes are easily explained, and in none of the many cases reported is there any conclusive proof that death resulted from a self-inflicted wound. It is also well known that a number of the so-called harmless snakes remain unaffected whether bitten by a venomous snake, or inoculated in the laboratory with enormous doses.

Considerable light has very recently been thrown upon this curious immunity, as well as the question of preventive inoculation, by the studies and experiments of two French physiologists, C. Phisalix and G. Bertrand, who are at the present moment, I believe, still engaged in further work along the same lines. They have published a series of articles in the Comptes Rendus of the French Academy of Sciences, describing their experiments with the venom of the viper. Having previously found that the blood of the toad and the salamander contain the same toxic principles they turned their attention to the viper. Guinea pigs were injected with the blood of the viper and died within two hours under the ordinary symptoms of Viper-bite poisoning; the post mortem examination gave the same result; and an examination of the poison in the viper blood showed it to be insoluble in alcohol. The authors conclude that there exists in the blood of the viper some agent similar to the venom; that it is due to an internal secretion of the glands, and that the presence of this toxic principle in the gland must be considered as the true cause of the immunity of the viper from its own venom.†

The next step was to examine the blood of some of the poison-proof harmless snakes, the two French species of *Natrix* being selected for the purpose. Guinea pigs injected in a similar manner as in the experiments with the viper blood gave similar results—they died in two

*Experiments on the Preventive Inoculation of Rattlesnake Venom. Jour. Physiol., Cambr., 1887, VIII, pp. 203–210.

†Toxicité du sang de la vipère (*Vipera aspis*, L.). Compt. Rend. Ac. Sc. Paris, CXVII, No. 26, Dec. 26, 1893, pp. 1099–1102. Extr. in Rev. Scientif. (4), I, No. 1, p. 23 (1894).

hours with all the symptoms of viper-bite poisoning. Having thus determined that there exists in the blood of the *Natrix* a poisonous agent in at least as great a quantity as in the viper and that the immunity of these snakes also is due to this cause, the question naturally arose as to the origin of the venom in the "harmless" snakes—in other words, by which organs is the venom furnished to the blood. Successive inoculation of organic extracts of the principal intestines, liver, pancreas, spleen, thymus, thyroid body, and salivary glands gave the result that only those of the latter had any effect at all and that this effect showed the characteristics of viper-venom poisoning. The natural conclusion is that the presence of venom in the blood of the harmless snakes is due to internal secretion of the salivary glands.*

The authors referred to had now reached the stage when they could look around for a suitable attenuation of the venom in order to secure a proper "vaccine," and they found that heat had this effect. Some of the results obtained by them by heating are not new—for instance, that boiling the viper venom for a few seconds affects it in such a way as to disassociate from it the local phenomena, the undestroyed portion left being practically elapid, or cobra, poison. When the authors therefore heated a lethal dose of viper venom and, after cooling, inoculated it into a guinea pig, they did practically nothing but inoculate the animal with a much reduced, nonfatal dose of cobra venom. The result of their experiments shows that this vaccination with the thus attenuated venom results in a certain amount of immunity. †

Naturally the authors next experimented with a view to ascertain the effects of the blood of the animals thus vaccinated. The experiments demonstrated the presence of the venom in the blood serum after three days (21st to 24th of January), and that this blood serum also possesses vaccinating properties. ‡ Of course, the results having been published on February 12, sufficient time had not lapsed to determine if the immunity thus obtained is lasting. The authors seem to be hopeful of obtaining such modifications of the blood as will enable them to utilize it as a therapeutic agent. Experiments and time alone will show.

It is but fair to add that Dr. Calmette claims priority for the discovery of the "serum" vaccine treatment. §

* Sur la présence de glandes venimeuses chez les Couleuvres, et la toxicité du sang de ces animaux. Compt. Rend. Ac. Sc. Paris, CXVIII, No. 2, Jan. 8, 1894, pp. 76–79.

† Atténuation du venin de la vipère par la chaleur et vaccination du cobaye contre ce venin. Compt. Rend. Ac. Sc. Paris, CVIII, No. 6, Feb. 5, 1894, pp. 288–291.

‡ Sur la propriété antitoxique du sang des animaux vaccinés contre le venin de la vipère. (Compt. Rend., Ac. Sc., Paris, CXVIII, No. 7, Feb. 12, 1894, pp. 356–358.)

§ See Henry J. W. Dam. Inoculation against Snake Poison. Dr. Calmette's Experiments at the Pasteur Institute, Paris. McClure's Magazine, III, October, 1894, pp. 460–468.

EXTERMINATION OF POISONOUS SNAKES.

It can be stated as a general rule that our poisonous snakes are decreasing rapidly in numbers, and that consequently the danger from their bites is constantly diminishing. In many localities where rattle-snakes were formerly numerous they have now become entirely exterminated, while in others they are extremely rare. The causes that have led to this are various, but the commonest cause is undoubtedly the increasing cultivation of the country. In other places the decrease in the number of the snakes can be traced directly to their being killed off by the hog, an animal certainly not proof against the venom if it enters the circulation, but usually well protected by its fat, which is in most cases sufficiently thick to prevent the fangs of the serpent from penetrating to the underlying tissues.

From other localities there is reported a similar decrease without it having been possible to offer a satisfactory explanation. As a striking illustration of this, I may cite the experience of an exploring party under Dr. C. Hart Merriam, camping for several months at the base of the San Francisco Mountain, Arizona, in 1889. The party consisted of a number of naturalists, specialists in mammalogy, ornithology, herpetology, and botany, who were busily engaged in studying the fauna and flora of that mountain for several months during the summer. Yet not a single rattlesnake was collected or seen by the party in that locality where twenty-five years previously Dr. E. Coues had collected quite a series of them, belonging to several species, during a comparatively short stay, notwithstanding the fact that the character of the country has apparently not changed in any essential particular. It has not been brought under cultivation; there are no hogs running about, only herds of cattle; no regular burning over of the ground takes place; no special enemies could be discovered; a few people pass occasionally through the district, and fewer still live there permanently.

On the other hand, there are instances on record of localities in which certain species of poisonous snakes have actually increased. This may occur in places, for instance, where the land was formerly burned over regularly every year, thus destroying the snakes in great numbers. Dr. H. H. Behr* attributes the increase in the number of rattlesnakes in some localities not far from San Francisco to the killing off of the enemies of the snake, notably birds of prey and other snakes, and probably correctly, while Mr. Hurter (Trans. Acad. St. Louis, VI, 1893, p. 258) reports a similar increase in western Illinois as due to the new stock law compelling swine to be penned up.

The poisonous snakes have a great many natural enemies which keep them in check, but there does not seem to exist in this country any animal which makes a specialty of the business and is particularly

* Proc. Calif., Acad. Sci. (2), I, 1888, pp. 91–99.

adapted for it, with the possible exception of some of the harmless snakes. We have seen that the latter, at least a great many of them, are poison-proof, and thus have but little to fear from the bite, and it is a well known fact that some of them are able to kill and eat a poisonous snake at least equaling them in size. Among the most redoubted enemies of the rattlesnake is quoted the common king snake or chain snake, *Lampropeltis getulus*, and the remnants of poisonous snakes are often found in the stomachs of other species.

This fact emphasizes the desirability of a correct discrimination between the poisonous kinds and the harmless snakes. The former ought to be killed and, if possible, exterminated wherever found; the latter should not only be spared, but protected and their multiplication encouraged, as they rank among the best friends of the farmer and the gardener.

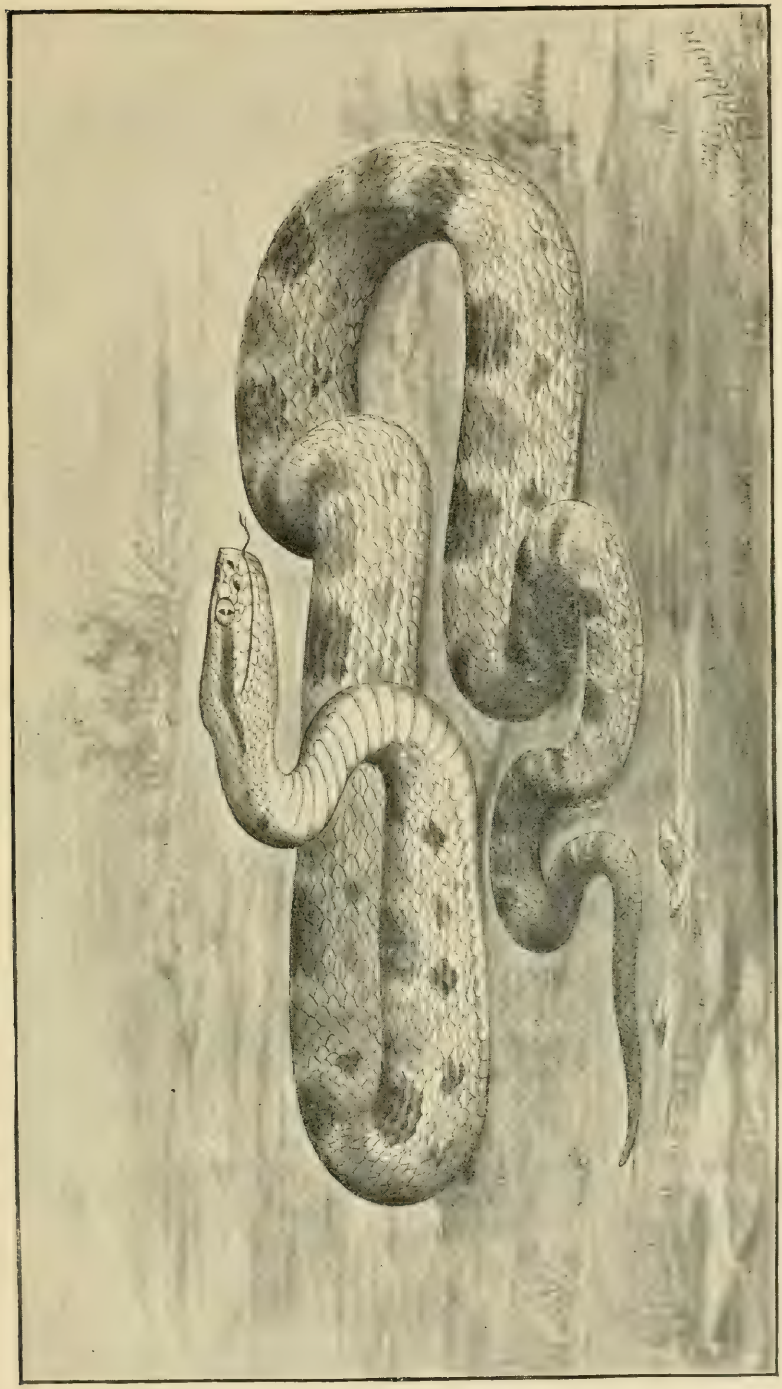
I do not know whether it has ever been tried anywhere in this country to pay a bounty or a premium per head, or rattle, for the extermination of the dangerous snakes, but it is occasionally suggested, and may deserve a moment's reflection in this connection, notwithstanding the fact that there are but few localities in North America in which the really dangerous snakes are numerous enough to render even an experiment with bounty desirable. It would be different, of course, if the system should have proved to possess any merit or to have been followed by success in countries where it has already been tried. A brief mention of some of the more noteworthy attempts in this line will show, however, that such has not been the case.

It has been tried and is still in vogue in India, where large sums are paid annually for the purpose. But it does not seem to do much good, except perhaps the moral effect in a country in which the dreaded cobra* is considered sacred by a great portion of the population. Even in the little island of Martinique, it appears to have had but scant effect in diminishing the number of the deadly "fer-de-lance."†

Prof. Kaufmann, in his book so often referred to, on the other hand, indorses the system as having been instrumental in diminishing the number of vipers in France, and submits that if it has not always given good results where it might be expected, the reason is solely that the system has not been applied in a thorough manner, in other words, that it has not been adopted over the whole country. In defense of this he appends a table showing the number of vipers killed in three "departments" (counties) since the beginning of the system. The table is very interesting, but as the results are very similar in all three (Haute-Saone, Doubs, Jura), I shall not weary the reader with more columns of figures than those from the department of Haute Saone as being most characteristic.

* For an illustration of this dangerous snake see pl. 18.
† See pl. 19.

INDIAN COBRA,—NAJA NAIA.
After Fayrer's "Thanatophidia of India."



WEST INDIAN "FER-DE-LANCE",—BOTHROPS LANCEOLATUS.

From a specimen in the U. S. National Museum.

Year.	Premium per viper.	Number of vipers killed.
	Francs.	
1864	0.25	1,934
1865	0.25	3,790
1866	0.25	4,354
1867	0.25	2,678
1868	0.25	2,147
1869	0.25	2,809
1870	0.25	877
1871	0.25	539
1872	0.25	243
1873	0.25	1,929
1874	0.25	1,636
1875	0.25	1,622
1876	0.25	2,505
1877	0.25	2,183
1878	0.25	5,394
1879	0.25	5,071
1880	0.25	15,130
1881	0.25	18,398
1882	{ 0.25 { 0.15	13,874
1883	0.15	1,058
1884	0.25	4,870
1885	0.25	18,084
1886	0.25	22,083
1887	0.25	27,053
1888	0.25	27,665
1889	0.25	39,031
1890	0.25	67,620
Grand total		294,577

Let us look at this table for a moment. Nearly 300,000 vipers killed during twenty-seven years in a department of France almost the exact size of the State of Delaware (Haute-Saone, 2,028 square miles; Delaware, 2,050 square miles)! Haute-Saone, in 1876, about the middle of the period covered by the table, had a population of 304,052 souls; consequently there is said to have been killed in one generation one viper for each human inhabitant! But let us analyze the table a little closer.

We observe first that in the years of the Franco-German war and those next following there was a great drop in the number of vipers killed, for the people naturally had other things to attend to. We also notice that when, in 1882, the authorities reduced the premium from 25 centimes to 15 centimes per viper the people evidently lost interest in the business, which must have become unprofitable, since the number killed suddenly dropped from nearly 14,000, in 1882, to a little more than 1,000, in 1883. The result evidently was that the authorities became alarmed at the possible increase of the dreaded reptile and again raised the premium to the old figure, undoubtedly to the great satisfaction of the snake hunters and a corresponding depletion of the county treasury. Furthermore, if we average the number of snakes killed during the six years before the war we will find that the annual average of vipers killed was 2,952, or nearly 3,000. The corresponding figure for the six years following the excessive drop caused by the war is 2,544, or somewhat less than the average of the first six years. Two conclusions seem warranted by these figures, first, that the average of these twelve years, viz, 2,748, represents the normal number which a diligent search throughout the department might yield; second that the decrease in the number of vipers killed during the years 1870–1872 did not materially increase the number of

vipers during the period following, unless it might be assumed that the premium had already effected a diminution of the vipers as early as 1867, which is, of course, barely possible. We would now be prepared for a constant decrease in the number of vipers killed yearly from 1879 on, but on the contrary, in 1880 the figures jump to 15,000, and with the exception of the years affected by the reduction of the premium, the number of alleged vipers killed is steadily increasing, until in 1880 it reaches the astounding number of 67,620!

At what rate must the vipers of Haute-Saone have been multiplying since 1880! And this is what Prof. Kaufmann considers a successful system.

The conclusion seems irresistible that the functionaries paying the bounty have either made false returns and pocketed the money, or else that they have paid for every snake brought in whether poisonous or not. The latter supposition would be the more disastrous one to the county, because of the enormous number of useful species that must have perished. One only wonders if a single snake is left in Haute-Saone.

But whichever of the two suppositions is the correct one, this case corroborates only the experience which has been had everywhere that bounties, as a rule, are failures where a nice discrimination has to be made by the premium-paying functionary, and that it very often leads to fraud both on the side of this official and on that of the bounty hunter.

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PLATES.

TEXT FIGURES.